PLOUGH AND PASTURE

PLOUGH

AND

PASTURE

BY

E. CECIL CURWEN

LONDON
COBBETT PRESS
81 CHANCERY LANE
1946

Volume Four in the series PAST AND PRESENT
Studies in the History of Civilisation

HODDESDON
THOMAS KNIGHT & CO., LTD.
THE CLOCK HOUSE PRESS

PREFACE

In this book an attempt is made to sketch the story of food production down the ages from its earliest beginnings to modern times. It would be quite impossible to deal in any detail with so vast a subject within the compass of so small a volume, and so I have tried to concentrate attention on a consideration of origins and broad principles, giving only such details as may be useful to illustrate the points made. Much has had to be omitted that some readers will miss—such as the details of modern progress—but I have had to be selective, and I have chosen to include what I believe to be the most important aspects of the subject for British readers. As a result the distant past is dealt with much more fully than more recent times, because the roots of the present go far back into the past, while the details of what is recent are more widely known or more easily ascertained. Origins, causes, principles—these are the important things, if we are to see our civilization in true perspective; and we cannot look ahead into the future with sound judgment until we have acquired a balanced understanding of what has gone before.

E.C.C.

ACKNOWLEDGMENTS

It gives me great pleasure to acknowledge the help given me in the preparation of this work by various friends, among whom I may mention the late Major G. W. G. Allen, F.S.A. (plates VII and VIII), Mr. O. G. S. Crawford, F.S.A. (plate V), Prof. Dorothy Garrod, F.S.A. (plate III), Professor Gordon Childe, F.S.A., and Dr. Wilfrid Jackson, F.S.A., F.Z.S., for helpful advice, and Professor J. Percival, Sc.D., who kindly supplied the specimens shown in Plates I and II. Plate XII is reproduced by permission of the Ministry of Information and the Ministry of Education.

CONTENTS

LIST OF ILLUSTRATIONS

PLATES

FIGURES

CHAPTER I

THE QUEST FOR FOOD

Apart from theft or plunder there are three ways in which you may obtain your supply of food.

(1) You may live by hunting, fishing, gathering wild fruits and leaves, and grubbing up edible roots of wild plants. Such *food-gathering* has obvious disadvantages, among which two predominate. First, with the exception of fish the wild products of nature are not sufficiently abundant to support more than a very small population, and existence under such conditions is extremely precarious. Secondly, the whole of your energy would be consumed in the quest for food, leaving none for any other kind of activity or for material or mental advancement. As a result life would be lived on the lowest level by a scanty, scattered and wandering population, with little hope of improvement. Among peoples who have lived by food-gathering in recent times—before the advent of European culture—may be mentioned the Eskimo, the natives of Tierra del Fuego, and the aborigines of Australia.

(2) Alternatively, you may produce your own food by cultivating certain plants, especially grain, and by domesticating certain animals. These two forms of *food-production* may be distinct, or they may be combined, and in the latter case their practice by nearly every family in the community forms the basis of *peasant culture*. Your supply of food is now under your own control, and you cause your plants and your animals to reproduce their kind how and where you will. Subject to the vagaries of the climate and the depredations of enemies your food-supply is comparatively secure and abundant. There is food enough for all your children and you can be fruitful and multiply. If you are a herdsman only, you will lead your flocks and herds ever in search of fresh pastures, so that your life will be nomadic and you will not have much opportunity for settling down to other activities. If, however, corn-growing is

your principal or only form of food-production you will live in a settled community and between seed-time and harvest you will have ample time to look about you, to observe nature and to improve your environment. Everything that you need you will produce or make for yourself, and the community in which you live will therefore be a self-supporting independent unit.

(3) A third way of obtaining a supply of food is to perform some useful work in return for which other people give you food, with or without the intermediacy of money. If this plan is widely adopted your community will be divided into two sections : those engaged in an *industry* other than food-production, and those who produce enough food to feed the whole community, and not merely their own families. Some degree of division of labour is found in all peasant communities, but this *industrial food-production* is particularly characteristic of *urban culture*, of which it is the basis. Its principal effect will be to set free still more energy for the propagation of the race and for various activities, constructive or warlike. The result of these activities will be to produce economic situations of ever-increasing complexity, with growing interdependence between communities, between town and country, between town and town, and even between nation and nation.

Generally speaking, these three forms taken by the quest for food have followed one another in the order set forth above, as successive stages of cultural evolution. There was a time when any sort of food-production was unknown, and when the meagre population of the world led a precarious existence by food-gathering. Then came a time when the possibility of producing and controlling one's own food-supply was discovered in at least one centre, and this knowledge, together with some of the most useful foods, vegetable and animal, diffused slowly among the food-gatherers of the world, leaving marginal areas where food-gathering has persisted down to our own days. Similarly, tendencies towards industrial food-production have arisen from time to time from very early days, giving rise to urban communities and in some cases ultimately

to empires. One may cite the early city-states of Sumeria, and the empires of Egypt, Greece and Rome, but the most extreme example has been the industrialization of European and American civilization that took place during the nineteenth century.

Now the change-over from food-gathering to direct food-production on the one hand, and from direct to industrial food-production on the other, was in each case an economic revolution the importance of which it would be difficult to exaggerate. We have already seen how in each case the principal effects were to make possible an increase of the population and to free energy for activities other than the quest for food. In studying the original rise of agriculture we can, then, draw certain analogies from our own Industrial Revolution. At that epoch the industrialization of the peasant culture of England, which had been going on quietly for some centuries, suddenly became much more complete, largely as a result of the invention of the steam-engine. People flocked from the country to the towns, great wealth was made by the few, and time, means, and energy were set free for exploring nature and the possibilities she offered for advancement. Out of this arose the development of science with the great discoveries and inventions of the past hundred years, among which those of electricity and the internal combustion engine seem likely to have even more far-reaching effects. Social and ideological changes have also followed, though here there has been more of a time-lag. The increasing complexity and interdependence brought about by industrialism has tended latterly to shift the emphasis from the individual to the state as the ultimate unit of society, and at the same time to reduce all individuals to social equality.

We shall consider presently what evidence we have as to the time and place in which agriculture first arose. Here we shall think only of its earliest effects. The growing of corn involved the stabilization of the population for some months, if not permanently, until the crop was harvested. Time and energy were thus set free for exploring the possibilities of nature, and we have evidence that discoveries and inventions of far-reaching

importance followed soon after the first adoption of agricultural life. Among the earliest and most important of these were metallurgy—the smelting of gold and copper—and the making of pottery, and these were followed by building, writing and the making of musical instruments on which scales of seven notes to the octave could be played. Material progress was, in fact, so rapid that the stage of industrial food-production was not long delayed in the areas in question. Social and religious changes also followed. Fertility cults now formed the chief basis of religion, for the chief aim of life was to increase production by improving the fertility of flocks and fields, and the planting of the seed and the subsequent appearance of the seedling gave rise to wistful longings for resurrection and a future life. As food-gatherers they had not had such stimuli as these, and their religion had presumably consisted of sympathetic magic and a belief in spirits. Instead, too, of scattered groups of independent food-gatherers, we now find communities firmly bound together under the authority of a priest-king.

Such in brief were some of the effects of the first adoption of agricultural life. We can now see in broad outline a picture of man's cultural evolution and of the fundamental importance of the food-quest as its determining factor. In fact, the rise of material civilization has only been made possible at all by the discovery of the possibilities of food-production in the twin forms of agriculture and stock-breeding, accelerated by the division of labour involved in its industrial exploitation.

CHAPTER II

THE ORIGIN OF AGRICULTURE

When and where were agriculture and stock-breeding first practised? At best we can only give approximate answers to these questions for the evidence that we have is circumstantial

rather than direct, being partly archæological and partly botanical and zoological.

Before citing this evidence, however, it will be worth while to notice the existence of certain traditions regarding the origin of agriculture. Traditions may have to be rejected as fantastic, but they are always worth considering because they not infrequently contain information of value, often distorted, and sometimes veiled in symbolism. Those quoted here are not only in mutual agreement as to the approximate location of the origin of the cultivation of corn, but they are also in agreement with the archæological evidence as understood at present, and are at least compatible with the botanical evidence.

All cultivated plants have been derived from wild varieties, and the first step in cultivating them consists in taking the seeds of the wild plants, sowing them in suitable soil, and by care and attention promoting their growth. The production of new varieties by deliberately crossing different strains is a later step. It may seem incredible to us that for countless thousands of years it never occurred to man to take this simple first step, but the very fact that he did not do so for so long emphasizes the magnitude of the discovery that eventually led him to take it. That discovery consisted in the knowledge that both plants and animals could be made to reproduce their kind under man's control. The fundamental character of this discovery is again shown by the fact that the cultivation of corn and the domestication of certain animals appear to have first taken place at approximately the same time, suggesting that the same principle —control of reproduction—was applied to both. As we shall see presently, the first plants to be cultivated were wild grasses bearing edible farinaceous seeds—the wild prototypes of wheat and barley. One very probable factor that may have prevented man for so long from discovering the reproductive function of the seeds may have been his eagerness to use every available seed for food, so that he never allowed himself the opportunity for experimenting with them.

The traditions, then, to which we refer, locate the origin of

corn-growing in some region between Egypt and Mesopotamia. The Egyptians believed that Osiris and Isis, their earliest mythical king and queen who were afterwards deified, introduced the knowledge of cultivation into Egypt and encouraged the arts of civilization. Isis, we are told, had discovered the fruits of wheat and barley growing wild, and Osiris devised means of cultivating them. Osiris, who was a native of Nysa in Syria or Palestine, also introduced from thence the vine, and taught its cultivation and the making of wine and the brewing of barley beer. He encouraged inventions, including the working of copper and gold, and ultimately toured the inhabited earth, notably Ethiopia, India and Greece, teaching mankind how to sow wheat and barley and how to cultivate the vine. 'And if any country did not admit the growing of the vine he introduced the drink prepared from barley, which is little inferior to wine in aroma and in strength'.[1]

Nysa, where Osiris had been born and brought up in a cave, is placed by Homer in Phœnicia, and by Pliny is identified with Scythopolis, the Bethshan of the Old Testament, a few miles south of the Sea of Galilee.[2] Perhaps it is rather to be identified with Byblos in Syria, once the scene of the annual festival of Adonis, the Semitic corn-god.[3] But whatever the exact location it is clear that a place or district somewhere in Syria or Palestine is meant.

The connection of Nysa with the mystic aspect of corn-growing is further emphasized by an allusion in Homer's Hymn to Demeter, the Greek goddess of corn. According to this it was while gathering flowers on the plain of Nysa that Persephone, the daughter of Demeter, was carried off by Hades—a myth which attempted to account for the effects of the seasons upon vegetation.[4] Though this story says nothing about the origin of corn-growing, yet taken in conjunction with the

[1] Diodorus Siculus, I, 14–20.

[2] Homeric Hymns, I, 8, 9; Pliny, Nat. Hist., V, 16.

[3] Lucian, *On the Syrian Goddess*.

[4] Homeric Hymns, II, 4–18.

Egyptian tradition it provides striking confirmation of the connection which Nysa was believed to have had with the beginnings of agriculture.

The Egyptian tradition looks like a memory of distant events, and suggests that what really happened was that the knowledge of the cultivation of wheat and barley, and of the making of wine and beer, was introduced into Egypt at a very early period —long before the first dynasty[1]—by a people coming from Syria or Palestine; that progress in the arts of civilization, particularly in metallurgy, resulted; and that this knowledge ultimately spread to Ethiopia, India and Europe. This corresponds surprisingly closely to the actual course of events as revealed by archæology.

The most striking tradition that has come down to us relating to this subject is that which is found in the Book of Genesis regarding Adam, Cain, Abel and their descendants. In this allegoric method of presenting history Adam may be taken as standing for the human race (Gen. v, 2). While in Eden he was a food-gatherer, but as a result of the acquisition of mystic knowledge ('Tree of knowledge') which had some connection with the reproductive function ('aprons of fig-leaves'), he became a tiller of the ground. The doom pronounced upon Adam included the words: 'Thou shalt eat of the herb of the field; in the sweat of thy face shalt thou eat bread' (Gen. iii, 18, 19). The phrase 'herb of the field' really means wild plants or grasses, so that this doom may be paraphrased: 'Thou shalt laboriously cultivate the wild grasses, out of which thou shalt obtain bread'. The subsequent division of food-producing man into two classes, cultivators and herdsmen, is symbolized by Adams' two sons, Cain and Abel, whose quarrel suggests that jealousy and feuds may have existed between these two classes of food-producers. At any rate it is very significant that it is the descendants of Cain, the cultivator, who are said to have built the first cities, practised metallurgy, and made the first musical instruments capable of playing scales. The location

[1] The first dynasty began about 3400 B.C.

of these events is indicated by the reference to the rivers Euphrates and Tigris, and to two other rivers of doubtful identity, one of which must be the Nile, and the other perhaps the Indus.[1]

Turning from tradition to fact, let us first see what botany can tell us as to the place or places in which plants were first cultivated. One way of approaching the subject is to assume that the first cultivation of a particular plant took place somewhere within the area in which the wild form of that plant is still found distributed. The difficulty here, however, is that we cannot be certain that at the time in question the distribution of the wild form was the same as it is now. In an attempt to overcome this difficulty the theory has been put forward that the area in which the greatest number of varieties of a particular cultivated plant is found is that in which the plant in question was first cultivated. This is based on the view that the longer a plant has been cultivated in a given district the more time there will have been for the formation of distinct varieties. Here again there is a difficulty, for there are other possible causes for the local multiplication of varieties. If, for instance, two or more groups of people meet and mingle, each having its own varieties of (say) wheat, the crossing of these strains of wheat may be expected to give rise to a larger number of new varieties in course of time than would otherwise have been the case in the district in question. There is thus no absolutely certain and infallible answer to the question to be expected from the botanical evidence alone, though we may expect it to throw valuable light on the problem, especially if both the above methods are used judiciously and in conjunction with the archæological evidence.

The research based on the theory that the scene of the origin of the cultivation of a plant corresponds to the area producing the greatest number of varieties of that plant is associated with the name of Professor Vavilov of Leningrad. Working on this hypothesis he postulates seven fundamental independent centres of origin of cultivated plants, each centre being associated with

[1] Cf. Josephus, *Antiquities*, I, i, 3.

the cultivation of different plants (for the most part), and with different methods of cultivation and types of agricultural implements. These seven centres are as follows :—

I. South-west Asia, comprising Asia Minor, Persia, Afghanistan, Turkestan and north-west India; among the principal cultivated plants the origin of which is attributed to this centre are: soft wheats, rye, flax, fruit-trees (apple, pear, sweet cherry), grape-vine, and many vegetables (e.g., beans, peas and carrots). Forests of wild apples, pears and sweet cherries, covered with wild grape-vines are still found in Transcaucasia and northern Persia. The agricultural methods of this centre are primitive, but extensive use is made of farm-animals, and there is great diversity of agricultural implements.

II. India, comprising the valley of the Ganges, the Indostan peninsula and the adjoining parts of Indochina and Siam; the cultivated plants that arose here are: rice, certain forms of naked oats and naked barley, millet, soya, sugar-cane, Asiatic cottons and tropical fruit-trees. Rice still grows wild in this area.

III. The great river valleys of eastern and central China; this is the centre for the radish, citrus plants, peach, tea, mulberry, and other less-known plants. In this area farm animals are seldom used, hand-labour being chiefly employed. It is from this centre that agriculture appears to have spread to Japan, the Philippines and Malaya.

IV. The Mediterranean basin, including the Iberian, Italian and Balkan peninsulas, the coasts of Asia Minor, Syria, Palestine, Egypt, Tunisia, Algeria and Morocco; ancient agriculture in this region was based on the olive, the fig and the carob, and oats and peas were developed here. Field crops, such as wheat and barley, borrowed from other centres have undergone careful selection here, promoted by the mild climate and by the high cultural level of the inhabitants, as a result of which there has been an increase in size and variety.

V. The mountainous part of East Africa, chiefly Abyssinia; this centre, Vavilov believes, has seen the first cultivation of wheat, barley, sorghum, and coffee.

VI. Southern Mexico, where maize, upland cotton and cacao were first cultivated, as well as some other plants.

VII. Peru and Bolivia—the centre for the original cultivation of the potato.

All these seven primary centres are situated in warm mountain regions, and this is a significant fact, for both the climate and the mountainous character of the country are factors promoting diversity of species. Even in the case of wild plants there is greater diversity of species in the tropics than elsewhere, and it is evident that tropical climate provides optimum conditions for the origination of fresh species. The broken character of mountainous country increases this tendency.[1] Factors therefore, which promote diversity of species may also promote the formation of new varieties.

Archæologists, however, are not inclined to accept Vavilov's theory altogether. The array of facts collected by the botanists are extremely impressive and call for some explanation, but whether the explanation given by them is the right one is open to doubt. Too many uncertain factors are involved, and the fact that a given area shows a greater number of varieties of a certain cultivated plant than any other may be the resultant effect of several different causes, such as climate and human migrations in addition to the antiquity of local agriculture. If the conclusions reached by the botanists agreed with those reached by the archæologists these doubts might not have arisen, but unfortunately there is a good deal of discrepancy between them. Vavilov's theory cannot, however, be entirely discarded, and time will no doubt show how the various differences can be reconciled.

Meanwhile we must look more closely into the origin of the cereals or grain-plants, wheat and barley, as it is these that have made possible the rise of material civilization.

There are many thousands of varieties of wheat at the present day, but these can all be placed in three groups comprising a

[1] N. I. Vavilov, *The Problem of the World's Agriculture in the Light of the latest Investigations*, Kniga (England), Ltd., 1931.

PLATE I.—WILD AND CULTIVATED WHEATS.

1, Wild Einkorn (*Triticum ægilopoides*, Bel.). 2, Einkorn (*T. monococcum*, L.). 3, Wild Emmer (*T. Dicoccoides*, Körn.). 4, Emmer (*T. dicoccum*, Schlib.). 5, Bread-wheat (*T. vulgare*, Host.). *Scales*: Ears, about $\frac{1}{2}$; grains, about $\frac{9}{10}$. *Ph.* E.C.C.

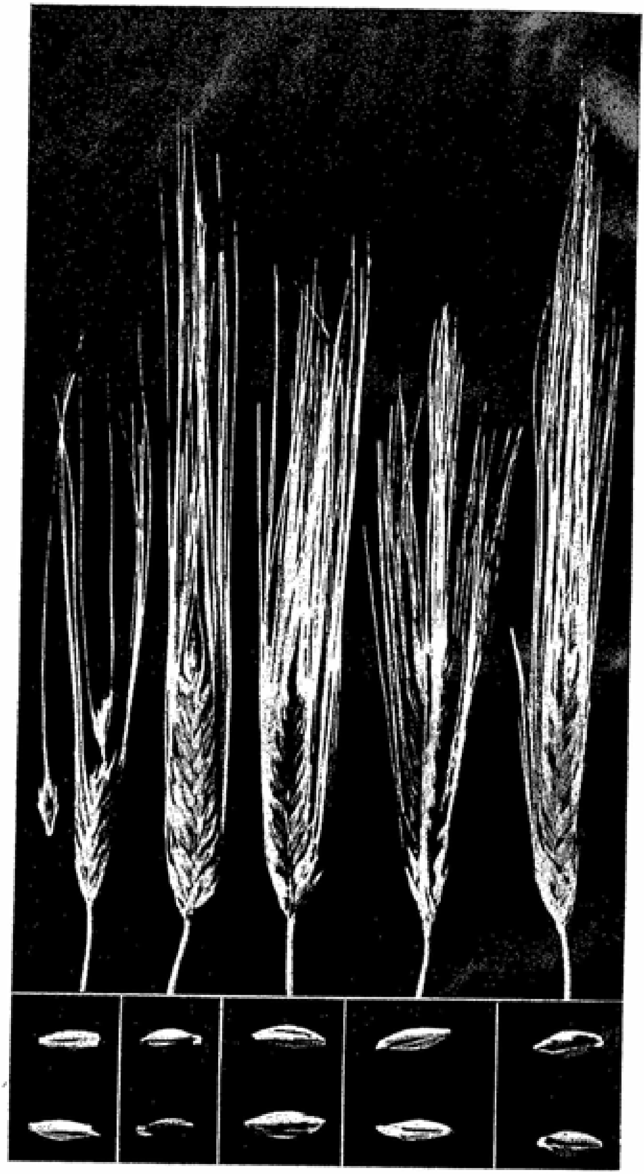


PLATE II.—WILD AND CULTIVATED BARLEYS.

1, Wild Barley (*Hordeum spontaneum*, C. Koch), broken ear. 2, Two-rowed Barley (*H. distichon*, L.), naked. 3, Six-rowed Barley (*H. hexastichon*, L.), husked. 4, Common Barley (*H. vulgare*, L.), husked. 5, Common Barley (*H. vulgare*, L.), naked. *Scales:* Ears, about $\frac{1}{2}$; grains, about $\frac{8}{10}$. *Ph.* E.C.C.

dozen species. It is possible that all may have been ultimately derived from two wild grasses known as Wild Einkorn (*Triticum ægilopoides*) and Wild Emmer (*Triticum dicoccoides*) (plate I). The following table lists the groups and the principal species of wheat and also three relevant barleys.

Species	Distribution, etc.
	WHEAT
	Group I, *with 7 chromosomes*
Wild Einkorn (*T. ægilopoides*) (plate I, 1)	Parts of Greece, Balkans, Crimea, Caucasus, Asia Minor, and Syria.
Einkorn (*T. monococcum*) ... (plate I, 2)	Cultivated in Central Europe in prehistoric times; now only in Asia Minor, Crimea, Switzerland, France, Spain in scattered localities.
	Group II, *with 14 chromosomes*
Wild Emmer (*T. dicoccoides*) (plate I, 3)	Syria, Palestine, Transjordan, and possibly Zagros mountains (Persia)
Emmer (*T. dicoccum*) ... (plate I, 4)	The only species cultivated in Egypt before Christian era and one of the principal species in Southern Europe till Roman times. Vavilov's centres of origin, Algeria, Abyssinia and Greece.
T. durum	Now the principal species from Egypt to Morocco; Vavilov's centre of origin, Abyssinia.
T. turgidum	Rare, but widespread in Europe and Asia, most diverse in Greece and Dalmatia.
T. polonicum	Locally grown in Mediterranean basin.
T. persicum	Georgia and Armenia.

Group III, *with* 21 *chromosomes*

Bread wheat (*T. vulgare*) ... (plate I, 5)	Common and widespread in Europe and Asia; Vavilov's centre of origin, Afghanistan.
T. compactum	Afghanistan.
T. sphærococcum	Northern India.
T. spelta	Little known.

BARLEY

Wild Barley (*Hordeum spontaneum* (plate II, 1)	Transcaucasia, Asia Minor, Russian Turkestan, Persia, N. Afghanistan, Syria, Palestine, Tripoli.
Common Barley (*H. vulgare*) Husked and naked varieties (plate II, 4, 5)	Vavilov's centres of origin, Abyssinia and somewhere in S.E. Asia.

Of the wheats only six are important for our purpose, viz. wild Einkorn, wild and cultivated Emmer, *T. durum*, bread wheat and *T. compactum*. The remainder are of little significance to the history of agriculture. These different species result from chance hybridization which breeds true from the first. On botanical grounds Emmer should be the most ancient cultivated species—a conclusion which is in conformity with the archæological evidence; the species in Group III are also more recent than those of Group II. While Einkorn (Group I) is derived from wild Einkorn, and the species of Group II probably in the main from wild Emmer, the origin of Group III is not certain. It is almost certainly a hybrid such as might result from crossing wild Emmer with wild Einkorn, or more probably with some other grass such as *Ægilops cylindrica* or *ovata*, as suggested by Prof. Percival.

Vavilov postulates that Emmer originated in Abyssinia, Algeria and Greece, the bread wheats in Afghanistan, and barley in Abyssinia, with another centre in south-east Asia. These results depend on the theory to which allusion has already been made,

that the area presenting the greatest number of varieties of a cultivated plant is the area of its original cultivation. How do these results accord with the conclusions of archæology? Before presenting the latter in a positive form it may be said at once that they do not encourage us to place unqualified reliance on the conclusions to which Vavilov's theory leads. Mr. Harold Peake has pointed out that at a time when agriculture was already known in Mesopotamia and Egypt (say, about 5000 B.C.) the climate of the Afghanistan mountains would have been too severe to permit the cultivation of the bread wheats, which are the least hardy of the wheats. As for Greece, agriculture was not practised there at all until perhaps 2,000 years after the cultivation of Emmer had been established in Egypt, so it can scarcely have been one of the centres of origin of cultivated Emmer. One is on less certain ground in regard to Abyssinia because little archæological exploration has been done there as yet, but there is no reason to suspect the existence of any very early agricultural peoples in those mountains. Much the same is also true of Algeria, though grain-rubbers were found by Vaufrey in late Mesolithic sites in North Africa, suggesting a very early interest in grain comparable with that of the Natufians of Mount Carmel (see below).

If, then, Vavilov's conclusions with regard to the places of origin of the cultivation of wheat and barley are not to be relied upon, we may still fall back upon the evidence of the present distribution of the wild forms, coupled with such positive evidence as archæology is able to afford. Here, in spite of the fact that we have no guarantee that their present distribution resembles that of, say, 8,000 years ago, we shall find that the results of the two methods of approach are mutually conformable.

The distribution of the three grasses, wild Einkorn, wild Emmer and wild barley is indicated in the table and in the maps (Fig. 1). The most important of these grasses, wild Emmer, has the most restricted distribution, viz., little more than Syria and Palestine, with a doubtful extension eastwards

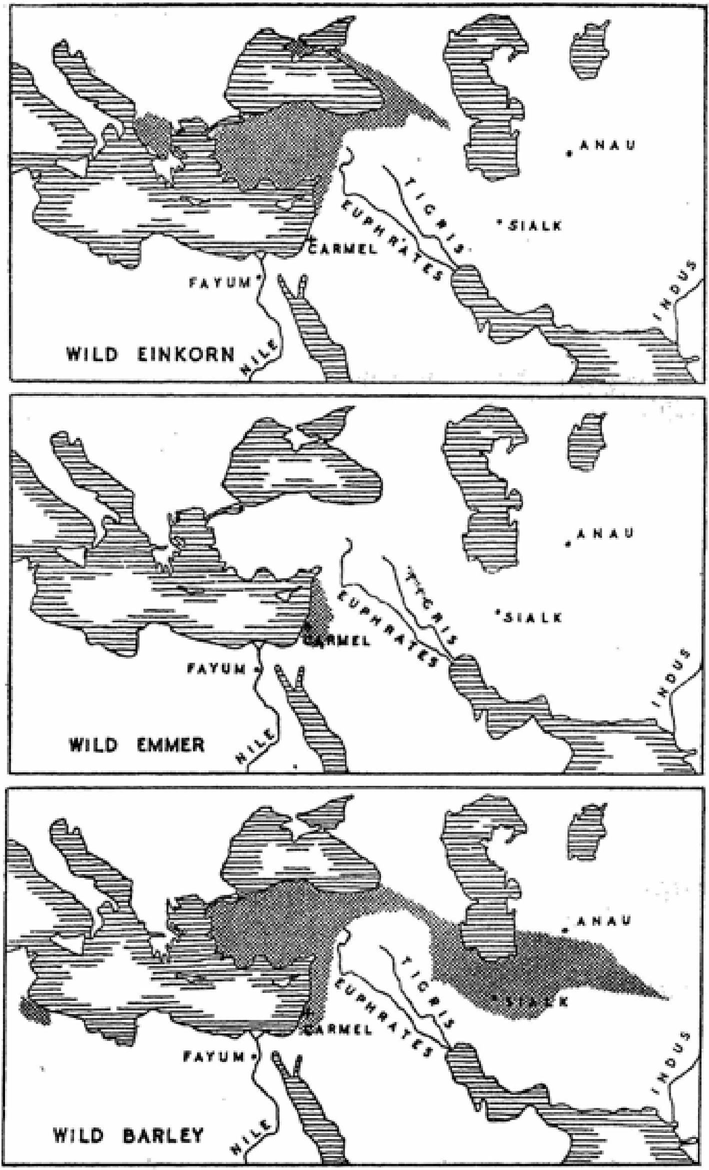


Fig. 1.—The approximate distribution of the wild ancestors of Wheat and Barley.

to the Zagros mountains. Couple this with the fact that the only area common to all three grasses is Syria, and we must conclude that, unless the distributions have greatly altered in the interval, Syria or Syria-Palestine is likely to have played an important part in their original cultivation. It is possible that each grass might have been cultivated first in a different district, but in view of the rather sudden development of food-production this seems on the whole to be less probable. If, too, the bread wheats were developed by crossing wild Emmer with another grass, this must have taken place in an area in which both grew wild. Seeing, also, that it has not been possible so far to establish precedence between the cultivation of Emmer and that of barley on archæological grounds, both are quite likely to have been cultivated simultaneously, and if so, Syria-Palestine is once more indicated as the scene. While admitting that there can be no certainty about these conclusions, there do at any rate seem to be strong *a priori* reasons to support them. If this reasoning is justified it may explain the importance of Byblos in Syria—the great centre of fertility-religion and of the worship of the corn-god, Adonis, in the ancient East.

On the other hand, the distribution of the wild grasses may not have always been quite the same as it is now, as we have already pointed out. At the time when on archæological grounds we believe that they were first cultivated, the ice was still retreating in Northern Europe after the great Ice Age. At the height of the latter the polar ice-cap had extended as far south as the River Thames, and the various climatic zones, which normally occupy the areas between the ice-cap and the equator, had been displaced southwards. At that time, long before the rise of cultivation, the zone of Atlantic storms and prevailing south-west winds which covers Britain to-day covered the coastlands of North Africa and the adjacent parts of Asia, and the Sahara enjoyed a rainfall similar to that of the Mediterranean lands to-day. With the retreat of the ice northwards the climatic zones also shifted north by imperceptible degrees, until, perhaps about 5000 B.C., the lands in question

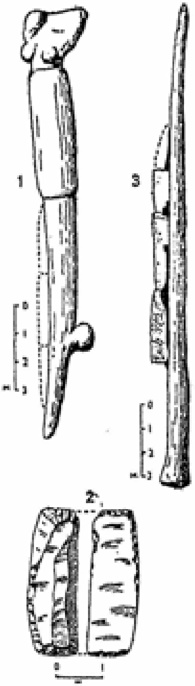


Fig. 2.—The earliest Flint Sickles. 1, *Natufian (Mesolithic), from Mount Carmel caves, Palestine: carved bone handle grooved to hold row of sharp flints as indicated by broken lines* (after *Garrod*). 2, *One of the Natufian sickle-flints; gloss shows that they have been used for cutting grasses such as wheat* (after *Garrod*). 3, *Neolithic, from a granary-pit in the Fayum, Egypt: wooden handle, with row of glossy flints in situ* (after *Caton-Thompson*).

grasses, just as they or their neighbours may have used flint picks or hoes for grubbing up edible roots. There is, at any rate, nothing known so far to suggest that the Natufians actually cultivated these grain-plants. Unfortunately, it is not yet possible to assign a date to their activities, but on the whole they are not likely to have flourished later than about 6000 B.C.

The first steps in actual cultivation may be inferred from the remains of some of the earliest settlements in Egypt. Here we find a definite Neolithic culture the date of which has been estimated as between 6000 and 5000 B.C., mainly on geological grounds. Three manifestations of this culture have been observed, their authors being known respectively as the Tasians, the people of the Fayum, and the Merimdians, after the places where their remains have been found.

The Tasians were still nomadic or semi-nomadic and lived mainly by hunting and fishing, but they had rough pottery and ground stone axes, and they used grain-rubbers—the most primitive form of apparatus adopted for grinding small grains like wheat or barley. Their settlements have been found near the east bank of the Nile in Middle Egypt, and it has been suggested that in view of the gradual onset of desert conditions they may, like the Hadendoa people of the eastern desert in the last century,

PLATE III.—MOUNT CARMEL CAVES WHERE THE NATUFIANS LIVED.

Flint sickles found in these caves provide the earliest evidence of man's interest in food-bearing grasses such as wild wheat.

Ph. : Prof. Dorothy Garrod.

have made use of the annual inundation of the Nile which not only waters the lands in the valley bottom, but renews its fertility by depositing fresh soil. Seeds sown in the wet soil just after the floods had subsided could be relied upon to yield a good harvest.

The Fayum people lived in settled groups on the shore of a lake which at that time filled the Fayum depression up to a level 190 feet above the surface of the present lake. The site, which is nothing but arid desert to-day, provides striking evidence of the change of climate to which reference has already been made. Besides practising some hunting and fishing the Fayum folk kept domesticated cattle, pigs and sheep (or goats), and they cultivated Emmer wheat and two kinds of barley which they reaped with flint sickles and stored in pits which were lined with coiled straw matting. In this case some of the actual grain was preserved, and an analysis of 800 grains proved that Emmer formed 20 per cent. of the total, two-rowed barley 23 per cent., and six-rowed barley 57 per cent. The barley was reported to be similar to that grown in Egypt to-day, but different from that grown in Tunis, Syria, the Danubian countries, Persia and India. The fact that no appreciable improvement has occurred in some 7000 years makes the sudden appearance of this grain at so early a date, without evidence of a long antecedent period of cultivation, difficult to understand. Flax must also have been grown as pieces of woven linen were found. A flint sickle, complete with its wooden handle, was found at the bottom of one of the granary-pits (fig. 2). The Fayum people also ground their corn on saddle-querns (see Chap. VIII), and they had pottery and ground stone axes, flint arrowheads and bone harpoon points.

Here, therefore, we have the earliest definite evidence, not only of the cultivation of wheat and barley, but also of the keeping of domesticated cattle, pigs and sheep (or goats). Sheep, as we shall see later, must have been introduced from Asia. The culture was still Neolithic, no trace of any metal having been found.

The Merimdians, whose remains have been found at the western edge of the Nile Delta, resembled the Fayum people in many respects. They grew Emmer wheat, used flint sickles, stored their grain in pits, and threshed it on threshing-floors. They also kept cattle, pigs and sheep (or goats).

These three Neolithic cultures disappeared from Egypt under the pressure of increasing desiccation. Some of their survivors may have migrated—in fact Childe thinks that the Neolithic cultures of western Europe may have been a belated emanation of the Merimdian, spread by very slow migration across North Africa and the Straits of Gibraltar.

These Neolithic cultures were succeeded in Middle Egypt by that of the so-called Badarians who came of a quite different racial stock. These people cultivated Emmer wheat and kept cattle and sheep, and they were the first to use metallic copper which they shaped by hammering and not by melting or casting. Among other things they had boats and we can now trace the beginnings of trade-relations with neighbouring peoples. They still depended, however, to some extent on hunting and fishing.

The Badarians were followed in Upper Egypt by the Amratians whose appearance marks the beginning of the predynastic period, the date of which is estimated to have been somewhere about 5000 or 4000 B.C. This culture contains new Libyan elements foreign to the Badarian, and the physical type of the people can be seen in the Beja of the Eastern Sudan to-day. They, like their predecessors, lived by their crops and their flocks, and also by hunting and fishing. They may have formed totemic clans living in autonomous villages, for there is as yet no evidence that they had a king or chieftain of any kind. Their stage of culture was similar to that of the Badarians, but they used alphabetiform signs, but not in such a way that they could be said to have practised writing.

In the middle predynastic period the Amratians were gradually infused with fresh blood which probably came in from Syria. This new culture is known as Gerzean, and it seems to be roughly contemporary with the earliest settlements so far known

in Syria and Mesopotamia. It is distinguished by greater richness and by technical superiority. Agriculture was now the basis of life, and hunting was less important. Villages were becoming towns. Flintwork attained its acme of perfection, while copper was still rare, though lead and silver were now known. The olive was cultivated in the western Delta, and they had the rudiments of a script based on older Palæolithic hunting signs. The people played a game like draughts, perhaps the ancestor of chess. We now find the earliest evidence of the existence of a king, and it has been suggested that the mythical Osiris may have preserved the memory of the first of the Gerzean kings who came from Syria. The archæological record, however, would by no means allow him to have been the first to introduce the art of cultivation, though he may well have improved it and raised its status.

It was probably in this period that the Egyptian calendar was introduced as an aid to agriculture, and as a means of foretelling the date of the annual inundation of the Nile—an event of the highest importance for the Egyptian farmer. The author of this calendar—one would like to think it was Osiris himself—established the length of the year at 365 days, but made no allowance for leap years. Hence every four years the real date would fall one day behind the calendar date, and in two centuries the real seed-time would come fifty days later than that indicated on the calendar. This error would accumulate until at the end of 1,460 years the full cycle was turned and the date on the calendar once more coincided with the actual date. This period of 1,460 years is known as a Sothic cycle, and as one such is recorded by the Roman writer Censorinus to have ended in A.D. 139 it is a simple matter to calculate the possible dates at which the calendar may first have been instituted, for this must obviously have taken place at the beginning of one such cycle. Thus it could have been instituted in or about 1322 B.C., 2782 B.C. or 4242 B.C. As the last date mentioned is the only one that fits all the known requirements it may be regarded provisionally as the correct one, and according to present

chronological estimates this would have fallen within the Gerzean period.[1] If this conclusion is correct it may be correlated with the advance in the status of Gerzean agriculture that we have already noticed.

After the Gerzeans a steady development in agriculture and material civilization took place in Egypt, which it is not necessary for us to follow here in detail. Suffice it to mention that during the early Dynastic period, i.e., about 3400-3000 B.C. the ground was broken up with flint hoes and the crops were reaped as before with flint sickles. Copper was becoming commoner, but was still far from common. Writing was in regular use and the wheel was beginning to be employed in the manufacture of pottery. This last emphasizes that pot-making had become a specialized craft and was no longer a domestic industry. Moreover, from the objects found in the settlements and graves of the early dynastic period it is clear that the kings of Egypt and of Mesopotamia were in direct or indirect communication with one another.

Before leaving the subject of early Egyptian agriculture it will be as well to emphasize that the increasing desiccation of the surrounding lands forced the migratory peoples to settle in the Nile valley where the annual floods not only watered the soil but renewed its fertility year by year. As a result of this the soil never became exhausted, so that permanent settlement was possible, and there was no need for primitive agriculturists to adopt a semi-nomadic existence as has usually been the case in less favoured lands. Artificial irrigation was no doubt practised in order to supplement the natural. It is also important to note that the wheat cultivated in Egypt from the earliest times right down to the beginning of the Christian era was Emmer. The principal species now grown in Egypt and throughout north Africa as far as Morocco is *Triticum durum*, a species belonging to the same group as Emmer (see table, p. 11).

We must now turn our attention to south-west Asia. Here

[1] Dr. Neugebauer has, however, recently denied the validity of this argument; see Childe, *Man makes Himself* (1939), p. 256.

we have already noted the Natufians inhabiting the caves of Mount Carmel in Palestine, probably before 6000 B.C., possessed of a typical Mesolithic (food-gathering) culture, and yet using flint sickles mounted in carved bone handles, presumably for the purpose of gathering wild grain. Something will be said in a later chapter on the subject of flint sickles, but here it may be noted that the bone handles of these implements each terminate in a kind of knob which is carved in the likeness of the head of an animal. In contrast to these we have seen that the handles of the Neolithic Egyptian flint sickles were of wood and, so far as they have survived, were not adorned with curved heads.

In order to see something of the beginnings of agriculture in south-west Asia we have to turn to Sialk—an ancient settlement-site near Kashan on the Iranian plateau, roughly half-way between the Caspian Sea and the Persian Gulf, and 120 miles south of Teheran. The Kashan oasis is situated at the west end of a depression which was once occupied by a large lake before the desiccation to which we have already referred set in. Between the mountains and the lake-bed are long terraces containing caves and broken at intervals by the beds of mountain torrents beside which wild cereals probably once grew. Though these caves have not yet been explored it is quite likely that they may have been occupied by food-gatherers who, like the Natufians, lived on the wild grain growing in the neighbourhood. At any rate the successors of the Natufians, or of their Iranian cousins, have left their traces in the two great mounds which mark the sites of two successive settlements at Sialk. The history of this site, as worked out by Ghirshman from his excavations there, falls into four periods, the last of which can be dated as having begun about 3000 B.C. The first three periods comprised no less than seventeen successive rebuildings of the village, each on top of the ruins of its predecessor. There is no means of determining the date of the beginning of the settlement except by forming a rough guess at the probable average duration of the mud or mud-brick houses of which

the seventeen successive villages were built. Under present conditions in Iran this kind of hut is expected to last for four generations—say, 120 years—but Ghirshman reckons that even if it lasted 75 years the date of the earliest settlement at Sialk would have been about 4300 B.C., while on the longer reckoning the date would make the beginnings of Sialk roughly contemporary with the Neolithic settlement in the Fayum in Egypt, to which it bears a cultural resemblance.

The earliest levels at Sialk reveal a purely Neolithic culture, but very soon copper begins to make its appearance in the form of awls, the metal being hammered into shape, and not cast. The huts were made at first of reeds plastered with mud, and later of *terre pisé*, not unlike our English cob; only in the second period do bricks begin to appear, and objects of hammered copper become more frequent. In the first period flint sickles were used, having bone handles adorned with carved heads, closely resembling those of the Natufians of Palestine; the ground was cultivated with stone hoes, and the grain was ground on saddle-querns.[1] Though hunting still formed an important part of their economy—the quarry including lions, panthers, wild oxen and gazelles—domestication of sheep and oxen was already in progress. Spinning and weaving were practised, and pottery was made, the vessels tending to imitate baskets in shape and decoration. In the second period the bone sickle-handles have disappeared, but since the sickle-flints are still found we must infer that they had been mounted in wooden handles like those of Neolithic Egypt. Moreover we now find bones of pig, dog and horse in addition to sheep and oxen, though it is still uncertain whether the horse was as yet domesticated or only hunted in the wild state.

We thus see that the evidence of the sickle-handles from Sialk does something to bridge the gap between the state of culture of the Mesolithic Natufians and that of the Neolithic peoples of the Near East.

Settlements contemporary with the first period at Sialk are

[1] For explanation of this term see Chapter VIII.

known to have existed at Nineveh on the Tigris and at Anau in Turkestan,[1] but nothing belonging to so early a period has yet been found in Southern Mesopotamia. This primitive culture, based on a mixture of food-gathering and food-production, may well have been ancestral to the later cultures of south-west Asia, including those of Sumer and Akkad, and it may also have been the source of the Syrian component of the Gerzean culture of Egypt.

There is no need to enter here into the complexities of the predynastic cultures of Mesopotamia. The fundamental importance of agriculture is seen running through them all, and most of the important inventions and discoveries make their appearance between 4000 and 3000 B.C. These include wheeled vehicles, the potter's wheel, writing (*c.* 3500 B.C.), the use of bronze (*c.* 3000 B.C.), and the making of glass beads (*c.* 2500 B.C.). Hoes made of flaked chert—a poor quality flint—were used at a very early period for breaking up the ground, long before they appear to have been used in Egypt, and the sickles consisted of serrated flakes of chert or obsidian set in clay mounts which were curved to resemble one half of an animal's jawbone. Cattle, sheep and pigs were kept from very early times, and the horse and ass appear rather before 3000 B.C.

The fourth millennium also saw the rise of temples and a priestly caste in Mesopotamia—a factor of extreme economic importance, as Childe has pointed out, for it made indirect food-production possible, thus paving the way for the earliest manifestation of the Industrial Revolution. The revenues paid to the priests, whether in the form of surplus food or any other kind of wealth, formed a reserve fund which enabled the priests to organize public works on a large scale or to finance foreign trade. This led to the rise of urban civilization and specialized industries so that wealth came to be reckoned in terms of goods other than food or domestic animals.

The botanists have had fewer opportunities of identifying

[1] The extremely early date originally claimed for Anau by Pumpelly is not now admitted.

the remains of actual grain found in excavations in south-west Asia than they have had in Egypt. Emmer wheat and barley were found at Arpachiyah in northern Mesopotamia at a level dating from about 4000 B.C. or rather earlier. But at Jemdet Nasr in southern Mesopotamia bread wheat was found—probably *T. turgidum*—dating from a little before 3000 B.C. Bread wheat and barley were also found in the earlier settlement at Anau in Turkestan which may go back nearly as far as 4000 or even 5000 B.C.

Another very ancient centre of civilization has been discovered in recent years in the valley of the Indus and the Punjab in north-west India. Its beginnings have not yet been revealed, but the further one traces back the civilizations of southern Mesopotamia and the Indus beyond 3000 B.C. the more they tend to converge as if differentiated from a common stock. In the third millennium the civilization of the Indus valley was equal to those of Egypt and Mesopotamia; it was already deeply rooted in Indian soil, and it is this that has formed the basis of modern Indian culture. Its economy was based on irrigation-farming in which a variety of bread wheat (*T. compactum*) was grown, as well as barley, cotton, dates, and perhaps rice. The domesticated animals included two kinds of cattle, buffaloes, sheep, fowls and elephants.

So far as it goes, therefore, the evidence suggests that, whereas Emmer was the only wheat cultivated in Egypt, bread wheats were the rule in south-west Asia and India. Thus the Egyptian wheats, ancient and modern, both belong to Group II, for which Vavilov postulates a centre of origin in Abyssinia, while the wheats found in Mesopotamia, Turkestan and north-west India are bread-wheats belonging to Group III, of which Vavilov's centre of origin is Afghanistan. There is obviously some connection between Vavilov's 'centres of origin' and the distribution of cereals in the surrounding ancient civilizations, but, as has been noted already, it is very doubtful whether his explanation can be accepted. If, as has been argued by Prof. Percival, the wheats of Group III (bread wheats) have

been derived from a crossing of wild Emmer with a grass (*Ægilops cylindrica*) which grows wild over an area extending from Eastern Europe to central Asia, we should expect the bread wheats to have a more northerly distribution than Emmer, seeing that one of the parent grasses does not grow—at present, at any rate—so far south as wild Emmer. Thus the Southern peoples, such as the Egyptians, having only wild Emmer, would cultivate it alone, while those living further north or north-east, having both wild grasses, would cultivate the product of their hybridization. Something of this kind seems actually to have happened, for, as we shall see presently, the cultivation of bread wheat also spread into the adjacent parts of Europe.

BOOKS AND ARTICLES

N. I. Vavilov, *The Problem of the World's Agriculture in the Light of the latest Investigations*, London, 1931; 'Studies in the Origin of Cultivated Plants,' *Bull. Applied Botany*, XVI, (1926).

A. E. Watkins, 'The Origin of Cultivated Plants,' *Antiquity*, VII (1933), 73.

Harold Peake, *The Origins of Agriculture*, London, 1928; 'The First Cultivation of Wheat,' *Man*, 1939, 36.

J. W. Page, *From Hunter to Husbandman*, London, 1939.

V. Gordon Childe, *New Light on the Most Ancient East*, London, 1935.

G. Brunton, 'The Beginnings of Egyptian Civilization,' *Antiquity*, III (1929), 456.

G. Caton-Thompson, 'Explorations in the Northern Fayum', *Antiquity*, I (1927), 326.; *The Desert Fayum*, R. Anthrop. Inst., 1935.

R. Ghirshman, *Fouilles de Sialk*, Paris, 1938.

CHAPTER III

THE ORIGIN OF STOCK-BREEDING

It is a striking fact that the earliest domestication of certain animals as a means of controlling food-supply seems to have taken place at approximately the same time as the earliest cultivation of cereals. The principle underlying each of the two forms of food-production is the same, namely, the control of reproduction, so that certain useful plants and animals, or their products, are to hand when and where they are wanted, and in

sufficient quantity. A further result of such control is that the wild forms undergo certain changes, so that new varieties appear from time to time. As the plant or the animal is to a large extent relieved of the struggle for existence, certain features tend to disappear and other features, more suited to a sheltered life, find an opportunity of developing. New varieties, too, appear from time to time as a result of hybridization, whether accidental or intentional.

While you may tame a single animal you can only domesticate a group of animals, for domestication (unlike taming) involves continuous breeding in captivity. How this was first done is a matter for speculation, but it has been suggested that the increasing desiccation to which allusion has already been made must have forced men and animals into closer association as they shared the gradually shrinking oases. Tribes that had lived principally by hunting would now become herdsmen, accompanying the flocks and herds in their annual migrations, protecting them from predatory animals, and gradually increasing their control over them. Such tribes would have retained a nomadic life in contrast to those which had settled down to agriculture in the irrigated river-valleys or in well-watered oases. The two main forms of food-production may thus have been practised at first by two distinct sets of people, leading quite different lives; on the other hand, the differentiation of food-producers into cultivators and stock-breeders may have been secondary, following upon the original discovery of the fundamental secret of the control of reproduction in plants and animals.

The animals with which we are concerned now are those which were principally useful as food. The dog, we know, had long been tamed by the earlier food-gatherers as an assistant in hunting; when he was too old to work he was eaten, like every other edible thing within reach, but he was not domesticated as a source of food himself—only as a food-getter. The earliest animals to be domesticated for their food value were those we still use for the same purpose, viz., cattle, sheep,

PLATE IV.—WILD SHEEP FROM WHICH OUR DOMESTIC BREEDS HAVE BEEN DERIVED.

Above : Mouflon ram. *Below :* Urial ram.

goats and pigs. The bones of these animals are found in the earliest agricultural settlements from the Fayum and Merimde in Neolithic Egypt to the first village at Anau in Turkestan, and they have been found in settlements of practically all subsequent agricultural peoples from India to Britain. Other beasts, such as the horse, the ass and the camel, were domesticated later, primarily for their value in transport or in war; the value of the ox for its labour in drawing ploughs and waggons was also a later discovery.

Unfortunately less is known about the ultimate source of domestic cattle, sheep, goats and pigs than about that of the cultivated cereals. That this domestication first took place somewhere within the area in which agriculture appeared is suggested by the fact that the earliest occurrences of the bones of these animals are in the earliest agricultural settlements, as we have already seen.

Perhaps this is most clearly seen in the case of sheep. There are at the present day four types of wild sheep; each type has its own distinct area of distribution, while the four areas together form a belt extending from the Mediterranean across Central Asia, up to the Behring Straits and across to Alaska, and down the west coast of North America as far as northern Mexico. The three of these that are most important for our purpose are shown on the map, fig. 3.

(1) The first is the Mouflon (*Ovis musimon*). This wild sheep once existed in Europe, but disappeared thence long before its domestication took place, so that domesticated descendants of the mouflon found in Europe must have been introduced by man from Asia. A few, however, still exist in a wild state in Corsica, Sardinia and Sicily. Elsewhere their natural habitat extends from Cyprus across Armenia to Persia. They are small, standing 2½ ft. at the shoulder, and they have brownish-red hairy coats with dark flank-bands, and white or speckled faces. The rams have curled horns pointing forwards and outwards; the ewes are mostly hornless (plate IV, *above*).

(2) The second type is the Urial (*Ovis vignei*). These are found

wild in an area extending from Russian Turkestan through Afghanistan to Baluchistan and also to Tibet. They stand 3 ft. high at the shoulder and are greyer than the mouflon. The horns of the rams usually turn inwards, while the ewes also have small goat-like horns (plate IV, *below*).

(3) The third type is the Argali (*Ovis ammon*) which roam wild over an area extending north-eastwards across Central Asia from the Pamirs to the Altai mountains and as far as Kamchatka. They stand 4 ft. high and are of a dark, dirty grey colour. Their horns are very massive, sometimes measuring over 6 ft. long (measured round the curve) and as much as 17 in. round the base. The ewes are also horned.

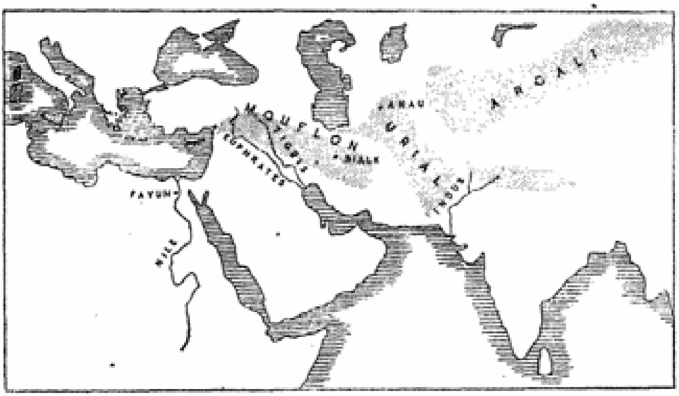


Fig. 3.—The approximate distribution of Wild Sheep in Europe and Asia.

(4) The fourth type is the Bighorn which is found along the Arctic coast of north-eastern Siberia, whence it extends into America across the Behring Straits. The horns are short and massive.

It is considered that all domesticated sheep have been derived from the first three of the above types, and those of Europe mainly from the first two—the mouflon and the urial.

The variations produced in the breeds by domestication and by hybridization affect such features as the horns, the coats and

PLATE V.—SOAY SHEEP IN HARRIS.
A descendant of the turbary sheep of prehistoric Europe.

Ph.: O. G. S. Crawford.

the tails. In the sheltered life of the domesticated flock the horns, which are weapons of offence and defence, become reduced in size and in some breeds have disappeared altogether. All wild sheep have hair coats; so had some of the earliest domesticated sheep of Mesopotamia and Egypt. The woolly fleece was developed as a result of breeding, but this had already appeared in Mesopotamian sheep as early as the fourth millennium B.C.

In the earliest settlement at Anau in Russian Turkestan, dating probably from the beginning of the fourth millennium, if not earlier, bones of both mouflon and urial occurred together with those of pig and a long-horned ox. At Sialk, too, on the Iranian plateau, bones of sheep and oxen were found at an equally early level. These are probably the earliest known agricultural settlements outside of Egypt, and they are situated within the present habitat of the urial and not far from that of the mouflon. In a somewhat later level the bones of an argali-urial hybrid occurred at Anau.

In Europe the earliest sheep are represented by two varieties found in the Neolithic lake-villages of the Alps. One is the turbary sheep (*Ovis aries palustris*), believed to be descended from the urial, and the other is the *Ovis aries studeri*, a large-horned beast descended from the mouflon. The primitive hairy sheep never reached Europe, for woolly fleeces had been developed before their introduction there. Bones of the turbary sheep have been found in Neolithic settlements in Britain, dating from around 2500-2000 B.C. The sheep of the Swiss lake-villages survive with little modification in parts of Europe to-day; among such survivals are the Drente breed of the Netherlands, with long tails and coarse, smooth wool. Such also are the Soay sheep, primitive descendants of the turbary, which have reverted to a wild state in Harris in the Outer Hebrides (plate V), and are also found in other remote parts of north-west Europe, such as the Faroes, the Orkneys, the Shetlands, and in Scandinavia. These sheep are of special interest in that they represent a survival from the very earliest period of breeding.

One of their primitive characteristics is a tendency to moult if their short wool is not plucked in the spring.

As recently as the Early Iron Age—shortly before the coming of the Romans—the sheep of Southern Britain still resembled the turbary sheep that had reached these shores over 2,000 years earlier—and the Soay sheep of to-day. It is from thes. primitive breeds that all European sheep have been derived. Recently, especially during the early nineteenth century, they have been crossed with breeds of different ancestry, such as the Merinos which, with the Norfolk Black Face, are said to contain argali blood. From such cross-breeding are derived various milch-ewes such as the Frisian ewe which may yield up to 110 gallons of milk a year.

It was not for nothing that the legend of the Golden Fleece was connected with the district of Colchis at the eastern end of the Black Sea, for in ancient times the finest fleeced sheep were developed in Asia Minor and exported from Miletus and Sardis. This breed was introduced by the Phœnicians to North Africa and Spain, and in Roman times Spanish wool was considered to be the finest, and Spanish rams fetched the highest prices. The development of fleeced sheep continued in Spain and culminated in the eighteenth century in the Merino, which was widely exported to France and Germany. Practically all the good wool-producing breeds on the Continent to-day have descended in some way from Merino strains, while the mutton-producing types are based more on English breeds.

Wild goats are related to wild sheep, and closely resemble them. Little is known regarding the history of their domestication. Like those of sheep, the bones of goats are usually found in early agricultural settlements, and representations of goats have been found in Mesopotamian monuments of an early period. Among these latter is the well-known figure of the so-called 'Ram caught in a thicket' which was found in the tomb of Queen Shubad at Ur, dating from before 2500 B.C. Actually the animal represented is a goat known as *Capra prisca*, with peculiar twisted horns. A horn of one of these goats was

found at Kish dating from very nearly the same period, whence the variety has been called the Kish goat. The same variety was known in Egypt about 2000 B.C., but the interesting thing is that it has survived in parts of Europe down to the present day—not, like the primitive Soay sheep, in the remotest parts of the north-west, but in those parts which are nearest to the ancient Orient and yet are more or less isolated by reason of their geographical position. These parts include Sicily, Malta, Crete, Greece, southern Albania and Bulgaria, while large herds existed on the shores of Lake Constance and in the Vorarlberg in the seventeenth century.

The history of the early domesticated ox is also somewhat obscure. Cattle are ultimately descended from small primitive ungulates represented by fossil forms found in Asia and Africa. The *Leptobos* was a wild ox found in Asia in Pleistocene times, i.e., contemporary with the old Palæolithic hunters, while at the same time the long-horned wild ox, *Bos primigenius*, or Urus, appeared in Europe. This urus survived in Britain until Neolithic times at least, and in the forests of Germany until the Middle Ages.

As in the case of the other food-animals, domestication of the ox must first have taken place in Asia, as bones of domesticated cattle occur in earlier settlements there than elsewhere. As with sheep, so with oxen, domestication leads to diminution in the length of the horns, and in some breeds to hornlessness. In the earlier site at Anau in Turkestan domesticated long-horned oxen occurred; at a rather later date the Anau folk had short-horned oxen (*Bos brachyceros*) and hornless sheep. As we shall see in the next chapter, the domestication of animals was introduced into Europe from the Near East, along with the knowledge of agriculture. The early European domestic ox was derived in varying degree from the short-horn (*Bos brachyceros*, also known as *Bos longifrons*) and from the wild urus (*Bos primigenius*). The cattle of the Neolithic lake-villages of Switzerland are described as *Bos brachyceros*, but a domesticated form of the urus was also known there. The same is true of the

cattle of the early agricultural peoples of the Danube valley and of Sicily and south Italy, and also of Denmark. In the Neolithic settlements of Britain, on the other hand, the cattle were uniformly long-horned, like the urus, but smaller in the body, and no trace of the short-horn has so far come to light in this period. The skull of a British Neolithic ox found at

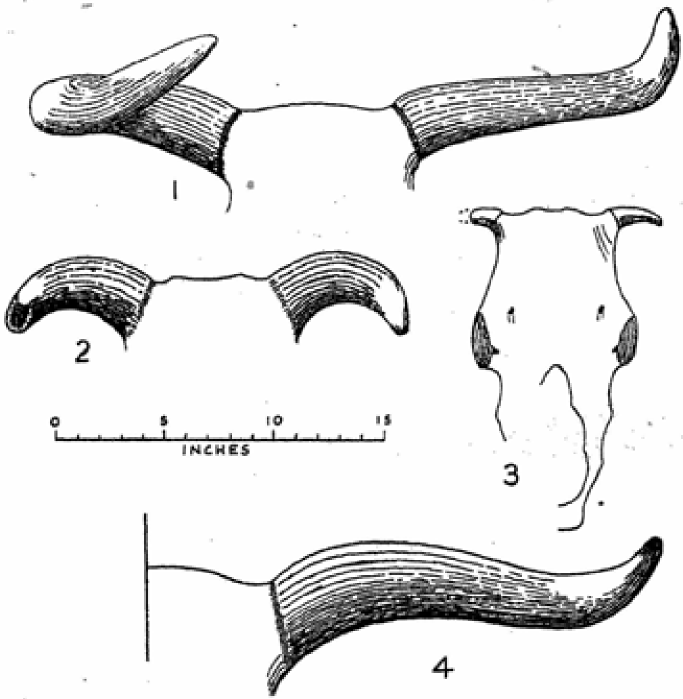


Fig. 4.—British prehistoric domestic Oxen. 1, *Neolithic long-horn, derived from* Bos primigenius ; *Maiden Castle, Dorset.* 2, *Ditto* ; *The Trundle, Sussex.* 3, *Iron Age short-horn* (Bos longifrons) ; *The Trundle, Sussex.* 4, *Horn-core of Urus* (Bos primigenius) *for comparison.*
(*All drawn to the same scale.*)

Maiden Castle, near Dorchester (Dorset), has horn-cores over 2 ft. long, so that the horns themselves must have been about 3 ft. long (fig. 4, 1). The type, of which this is an extreme

example, has clearly been derived from the urus. Even without the horn-cores this variety can be recognized by the breadth of the forehead between the bases of the horns, for the longer the horns are, the broader is the forehead. In these long-horns this distance is from 6 to 8 inches, contrasting with less than 5 inches in the case of the short-horns. Their modern representatives are the Scottish Highland cattle.

The so-called Celtic short-horn (*Bos brachyceros* or *Bos longifrons*) first appears in Britain in the Late Bronze Age, after 1000 B.C., having been introduced by Celtic-speaking peoples who came ultimately from the Alpine districts where this short-horn had been kept since Neolithic times. Thereafter it was the normal breed in Britain till the coming of the Romans, and the long-horns are seldom, if ever, found during the Iron Age. These latter do, however, re-appear in a slightly modified form during the Roman period. The short-horn was a very small beast, with long, narrow forehead, and horn-cores from 2 to 4 inches in length, implying horns from 3 to 6 inches long (fig. 4, 3). It is probable that modern British cattle have all been derived from cross-breeding between these two varieties. The various breeds recognized by cattle-breeders are of comparatively recent origin, and result from artificial selection.

Dairy-farming is of great antiquity, though naturally it has left few traces in the archæological record. Pictorial records in Mesopotamia show that it was practised there by 3000 B.C. There can be little doubt that it was of importance wherever domestic cattle were introduced. In Europe we can only get dim glimpses of it through the occasional discovery of what are considered to have been cheese-making vessels—bowls having one large hole in the base and many small holes in the sides. None of these is earlier than 1000 B.C.

Pigs were early domesticated, like cattle, sheep and goats, therefore this process is likely to have first taken place somewhere within the same area. They have been derived from the wild boar which was very widely distributed in Europe, Asia and north Africa. On the other hand, pigs were the only

animals domesticated by the earliest Chinese farmers who may perhaps have made an independent discovery of the secrets of food-production.

Chickens first appear in the archæological record in the cities of the Indus civilization, about 3000 B.C. It is quite likely that they may have been domesticated in that region, as the wild species still flourish in the foot-hills of north-west India.

Thus far we have seen that most of the earliest agricultural peoples possessed the four important food-animals—the ox, the sheep, the goat and the pig. Although the cultivation of cereals and the domestication of food-animals appear to have originated in approximately the same area and at about the same time, it does not follow that these two forms of food-production were practised by the same people. In all probability the reverse was generally true, corn being grown by settled cultivators, while the flocks and herds were bred and tended by nomadic tribes. Thus the animals whose bones are found in the early settlements were not necessarily bred there, but may have been obtained from the nomadic pastoralists in the course of trade.

The domestication of the horse came later. Wild horses once roamed most of Europe and Asia north of the great mountain chains. Out of four recognized varieties two are of special importance, viz., the tarpan, which inhabited Europe north and west of the Black Sea, and Przewalski's horse which roamed over eastern Russia and Asia. The tarpan finally became extinct a century ago in the Steppes of south Russia, while Przewalski's horse still survives in very small numbers in Mongolia. It is probable that the tarpan is the most important ancestor of the domestic horse, though there may well have been cross-breeding with Przewalski's. One theory is that the horse was first domesticated on the grassy steppes of south Russia, and Peake thinks that this had taken place before 2600 B.C. and that the men of the Steppes had already learnt to ride them by that time. This is likely enough, but the evidence is scanty. Early in the third millennium B.C. in the Kuban, north of the Caucasus,

horses were buried in the graves of the chiefs along with other domestic animals. But that the riding of an animal of horse type—whether horse, ass or onager—was known in Elam at a still earlier date is proved by the finding at Susa, on the shore of the Persian Gulf, of a representation of a man riding such an animal, dated to the fourth millennium. Not long after this the horse first appears in Mesopotamia, and one is tempted to wonder whether the Elamite figure may not have represented a horseman from the Russian Steppes. At any rate the evidence suggests that wherever the horse was first domesticated its purpose may have been primarily for riding rather than for food, though its flesh was undoubtedly eaten as well.

It was a long time before the domestication of the horse spread over the rest of Europe, and when it did it arrived independently of the four food-animals. Seeing that the horse roamed wild in Europe it is difficult always to be certain whether the bones found in a settlement are those of a domesticated horse or of a wild one which had been hunted along with deer and boars. We have seen that the horse was already domesticated in the South Russian Steppes soon after 3000 B.C. It was likewise known to the early peasants of the Danube valley not many centuries later. In Poland, Scandinavia and Britain it was known by, or very soon after, 2000 B.C., and it may have been introduced to northern Europe by the wandering tribes known to archæologists as the Battle Axe folk. Indeed it has been suggested that the surprisingly extensive migration of these people may have been facilitated by their possession of domesticated horses. In Britain the remains of horses do not appear till the very end of the Neolithic period (after 2000 B.C.), though there is a little evidence that wild horses existed here in earlier (Mesolithic) times. The Neolithic 'A' folk of South-East Britain, though possessing the four food-animals and hunting deer, knew nothing of the horse, whether domesticated or wild.

Curiously enough, though the domesticated horse appears so early in the Russian Steppes and in Mesopotamia, it was just as late in reaching the countries round the Mediterranean as it was

in reaching Britain and Scandinavia. Thus remains of horses appear in Sicily only after 2000 B.C. and in the Troad (north-west Asia Minor) about 1400 B.C., while in Egypt horses first appeared in the sixteenth century B.C., having been introduced there by the Hyksos invaders who came from Asia. All this evidence favours the Steppes of South Russia as the scene of the first domestication of this animal, where it was probably tamed for riding, perhaps as early as the fourth millennium B.C.

The Greek legends concerning centaurs—mythical creatures that were half man, half horse—no doubt preserve the memory of the reactions of the early Greeks when they first experienced the incursions of northern barbarians riding on the backs of horses.

BOOKS AND ARTICLES

J. Cossar Ewart, in *Trans. of the Highland and Agricultural Soc. of Scotland*, 1904, 1913, 1914.
M. Hilzheimer, 'Sheep,' *Antiquity*, X (1936), 195.
Antiquity, XI, 226; XII, 81.
C. Bryner Jones, 'The Origin and Development of British Cattle,' *Proc. First Internat. Congress Prehist. Sciences* (London, 1934), 151.
J. Wilfrid Jackson, 'Prehistoric Domestic Animals,' *ibid*, 154.
M. Hilzheimer, 'The Evolution of the Domestic Horse,' *Antiquity*, IX (1935), 133.

CHAPTER IV

THE EARLY SPREAD OF AGRICULTURE

HITHERTO we have seen that food-production, which depended upon the cultivation of wheat and barley and the domestication of the ox, sheep, goat and pig, must have originated at some point within an area bounded on the west by the River Nile, on the east by the River Indus, and on the north by about the forty-fifth parallel. This conclusion is based mainly on the evidence of archæology, but it is also supported by that of botany and of zoology. To-day food-production is practised

over the greater part of the habitable world, either as a result of diffusion of knowledge, grain and animals from the original focus, or else as a result of independent discovery wherever the necessary conditions happened to prevail. Considerable controversy has raged between the supporters of these two rival theories, but, as in the case of so many controversies, the truth probably lies between the two extremes.

Thus there is very little doubt that the agriculture practised in the New World, based on the cultivation of maize and the potato, was an independent discovery, for the pre-Columban population of that continent were in the food-gathering stage when they migrated there from north-east Asia via the Behring Straits. It is possible that the earliest agriculture of China may also have resulted from an independent discovery, for it was based on the cultivation of millet and the domestication of the pig, and though both these commodities were known in south-west Asia there is so far no archæological evidence to connect the two areas at the early date required.

On the other hand there can be no doubt at all that over large parts of Europe, Asia and Africa the knowledge of food-production was spread by diffusion, and there is not the slightest ground for believing that European agriculture had an independent origin.

Professor Gordon Childe has shown how this diffusion took place. Some of the more fortunately placed peasant-communities, such as those occupying the river-valleys of Mesopotamia and Egypt, prospered to such an extent that they passed from direct food-production to industrial food-production, and from peasant culture to urban culture (see Chap. 1). The energy thus set free was spent in organizing their communities under the control of kings and priests who levied taxes which were to be paid in food-stuffs. The surplus of food thus produced by the peasants and stored in the temples became available (*a*) for feeding the ruling class, (*b*) for exporting in return for desirable imports, and (*c*) for feeding members of the community who spent their time doing and making things

that benefited the community as a whole, including digging and building and all kinds of artisan work. In this way urban culture arose, with an increasing proportion of the population engaged in some form of industry instead of in direct food-production. This led to an increasing need for imports of materials that were either useful, as copper ore and timber, or had reputed magical or ornamental virtues, as shells from distant shores, and this in turn necessitated increasing exports of grain or manufactured goods. Such trade may have been effected at first through the intermediacy of wandering pastoral tribes, but there came a time when the need for permanent trading-stations arose. These trading-stations in their turn became industrialized urban communities ; Byblos in Syria, for instance, became a city because of Egypt's need of timber from Lebanon.

Such trading-stations grew up in various parts of the Near East, and as each became in its turn more urbanized it tended to develop subsidiary trading posts of its own still further afield. Punitive expeditions were also sent occasionally to coerce reluctant producers, and as soldiers are as much a product of industrialization as artisans and traders, wars and conquests became increasingly common. This, again, led to migrations of refugees who carried with them valuable knowledge and materials to their new homes.

This tendency towards urban culture was very gradual at first, and a pronounced degree of industrialization did not become apparent in the great river-valleys until late in the fourth millennium, with the rise of the dynasties of Egypt and Mesopotamia. And it was not until about 3000 B.C. that agricultural economy began to be diffused in the direction of Europe. These two facts are evidently closely related in the way that we have already seen. In other words the diffusion of agriculture was one of the direct results of industrialization. In fact the third millennium was the period which saw the spread of agriculture and stock-raising from the Near East to Britain and Scandinavia, where its arrival coincides with the beginning of what we know as the Neolithic period.

There were two principal routes by which the new way of life reached the north-west of Europe. One route lay by way of Troy (in north-west Asia Minor) and the valley of the Danube; the other depended on coastal trade by sea via the Mediterranean and the Atlantic coasts of Portugal, Spain, Brittany and the western parts of the British Isles. The dividing line between the spheres of influence belonging to these two trade-routes coincides approximately with the Rhine, and the differences which have always existed between the peoples who live on either side of this river may perhaps derive their ultimate origin from this fact.

The elements of food-production which thus percolated into Europe along with the Neolithic culture included the four domesticated food-animals—the ox, sheep, goat and pig—as well as the two staple cereals—wheat and barley.

In addition to these we have to notice that millet (*Panicum miliaceum*) was cultivated in the warmer and sunnier climates. This cereal, according to Vavilov's theory, originated in India, but it was the only cereal cultivated in China at the dawn of her agriculture. It has been found in early agricultural settlements in Anatolia and in southern Europe, including the south Russian steppes, the Ukraine, Thrace, Macedonia, the Alpine lake-villages, and Portugal.

All three wheats—Einkorn, Emmer and bread-wheat—found their way into Europe as the knowledge of agriculture spread. Einkorn, as we should expect from the distribution of its wild forms, was grown at Troy, in the Ukraine, and in the settlements on the Danube, whence it spread to a very slight extent to the Swiss lakes and to Denmark. Emmer has been found in a rather more westerly distribution, perhaps indicating that it may have travelled by the Mediterranean-Atlantic route. It has been identified in the island of Lesbos in the Aegean, in the Alpine settlements, and in the Rhineland, Belgium and Denmark. Bread-wheats, on the other hand, which, as we have seen, were particularly developed in Mesopotamia, Persia and Turkestan, have a fairly wide distribution in Europe, including

the Ukraine, the Danube valley, the Alps, Greece, Denmark and Britain. On the whole it seems probable, as Peake suggests, that bread-wheat was the chief form of wheat reaching Europe by the Danubian route, while it is pòssible that Emmer may have been diffused by the sea route.

In addition to cereals fruit-trees were cultivated in certain localities, as well as beans, peas, lentils and flax. Although the remains of these fruits and vegetables have only been found where the accidental circumstances of soil, humidity or carbonization have preserved their seeds, we may infer that they formed an important element in the system of agriculture that first percolated into Europe from Asia. Among the fruits, olives, vines and figs were cultivated in various parts of the south; pears were grown in Greece, and apples, whether cultivated or wild it is difficult to decide, grew near the Alpine lake-villages and were used by the inhabitants, probably for making cider. Beans, peas and lentils were also grown by these people, as well as by the early Danubians.

This list is inevitably sketchy, and is only intended to provide a glimpse of the agricultural activities of the earliest European farmers. The perishable nature of the evidence could not allow it to be otherwise, for it is only in peat that one can expect to find the remains of plants at all well preserved, and peat is found in only a few localities such as the beds of Alpine lakes and the moors of Denmark and the British Isles.

The Danish investigators, Georg Sarauw and Knud Jessen, therefore sought for an alternative method of determining the character and the relative abundance of cultivated plants at various dates. The method they adopted was based on the fact that in prehistoric times—in Europe at any rate—the pottery vessels were made by the women of the house and baked on the domestic hearth. No potter's wheel was used, but the clay was simply thrown on to the floor of the hut and there shaped by hand. As the floor was frequently littered with food-refuse, especially grain and other seeds, the impressions of these small objects are often discernible in the clay after the baking of the

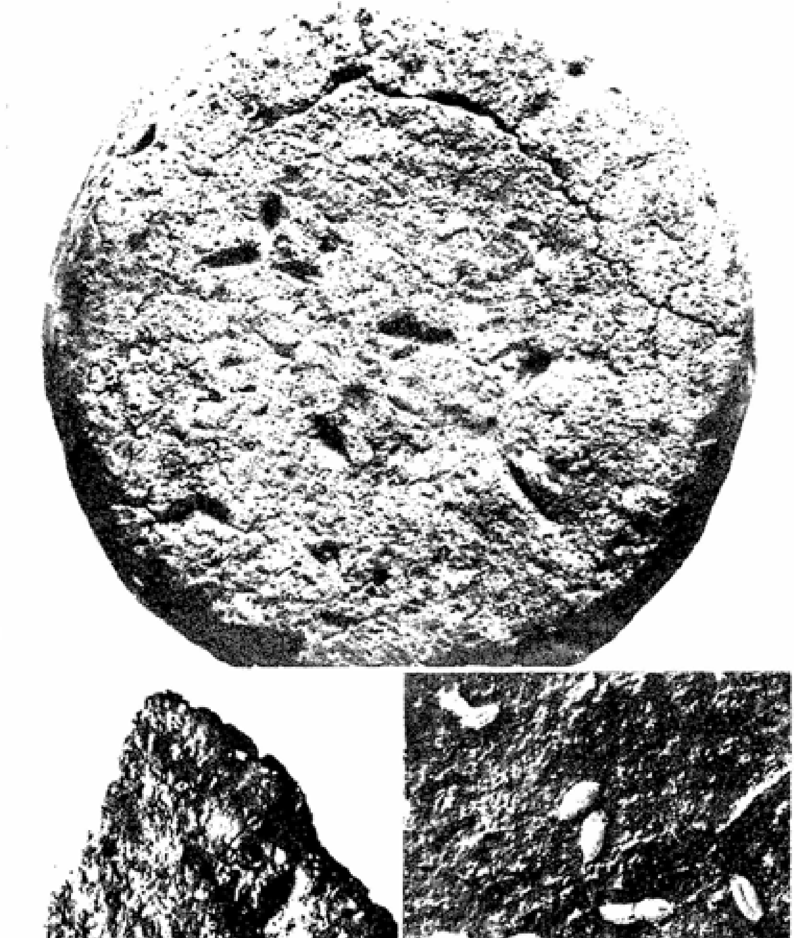


PLATE VI.—IMPRESSIONS OF BARLEY ON BRITISH PREHISTORIC POTTERY.

1, Base of Iron Age pot. 2, Sherd of Neolithic pottery from Whitehawk Camp, Brighton. 3 and 4, Plaster positives of Nos. 1 and 2, suitably coloured. *Phs.:* E.C.C.

pots (plate VI). Sarauw and Jessen therefore examined the surfaces of all the prehistoric pottery vessels found in Denmark, classifying them according to their various periods, and identifying the impressions of the grain and other seeds that they found on them. Their results are so illuminating for the early history of Danish agriculture that the National Museum of Copenhagen undertook to extend this study to all the prehistoric pottery of Europe, in the hope of identifying thereby the routes by which different varieties of grain originally travelled. Unfortunately these plans have been checked by the War, at least temporarily. The identifications are made by pressing a suitable plastic material into all suspected cavities on the surfaces of pots or broken shards. Some of these cavities will have been made by small stones which have fallen out of the clay, but others will be found to preserve the form of grains or seeds which can now be recognized by the shape and dimensions of the positive impressions in the plastic material (plate VI) Great skill and experience is necessary in distinguishing varieties of grain, and some differences of opinion inevitably arise between experts, but on the whole there is fair unanimity.

Working upon this basis Sarauw and Jessen found 425 impressions of grain and seeds on Danish Neolithic pottery—enough to give a sample of the crops cultivated by the earliest Danish farmers between, say, 2500 and 1500 B.C. Of the impressions of grain 87 per cent. was wheat, and 13 per cent. barley ; while of the wheat no less than 81 per cent. was Emmer, 13 per cent. was bread-wheat, and only 6 per cent. was Einkorn. Of the barley impressions the majority are of the naked variety, the husked kind to which modern varieties are related forming about a quarter of the total. Besides these there were thirteen impressions of apple-pips, and three made by the seeds of the weed *Polygonum*, of the Buckwheat family, which, though relatively scarce at this early period, may have some significance.

Pottery of the Early and Middle Bronze Age of Denmark (1500–800 B.C.) is scarce, so that we have not enough impressions of seeds from which to draw inferences as to the grain culti-

vated at this period. But for the Late Bronze Age (800–400 B.C.) there is plenty of material, and now we find that the relative proportions of wheat and barley are reversed, for barley now forms 87 per cent. of the total grain, and the husked and naked varieties appear in nearly equal proportions. Emmer is half again as frequent as bread wheat, and we now have two new grains appearing, viz., millet and oats, each forming about 2 per cent. of the whole. Millet requires a warmer climate than that which has prevailed in Denmark in historic times, and its appearance there in the Late Bronze Age is in keeping with the fact, known from other sources, that the climate was exhibiting a relatively warm and dry phase at that time. Oats (*Avena sativa*), derived by cultivation from the wild *Avena fatua*, which is a native of southern Europe and western Asia, was originally a weed contaminating crops of barley and Emmer. In warmer climates it grew unwanted among the main crop, but as Emmer spread to higher altitudes and to northern latitudes it gradually came to be replaced by the more hardy oats, for it is well known that oats will grow in cold, damp climates in which wheat will not thrive. It was then that the value of oats came to be recognized, and the crop was cultivated for its own sake. This did not happen in Europe till after 1000 B.C., as we know from remains found both in Switzerland and in Scandinavia. *Polygonum* seeds have now risen to nearly 10 per cent. of all the impressions, and peas and beans appear for the first time.

In the pre-Roman Iron Age in Denmark (400–1 B.C.) the climate underwent a sudden deterioration, becoming much colder and wetter. Out of 155 impressions on pottery of this period *polygonum* seeds form no less than 80 per cent.—a fact which may mean that this weed was now deliberately cultivated, perhaps as winter feed for cattle, which on account of the change of climate could no longer be left out on the pasture in winter. Quantities of *polygonum* seeds have also been found in the Swiss lake-villages. In Germany they were used for making porridge as recently as last century, and in Russia and

Sweden they have been used for fodder, and even for distilling instead of grain. Emmer has finally disappeared, and barley is thirty times as common as wheat, the proportion of naked to husked varieties being five to one.

In the Roman Iron Age of Denmark (A.D. 1–500) barley forms 81 per cent. of the total cereals, and the husked variety now predominates over the naked in the proportion of nearly three to one. Wheat forms about 2 per cent. of the total, while the proportion of oats has risen to 9½ per cent,. in addition to 2 per cent. of wild oats. Rye (*Secale cereale*) appears for the first time, forming 5½ per cent of all the cereals ; this grain also was originally a weed contaminating bread-wheat, but being more hardy tended to supplant the original crop in northern latitudes. It came into prominence at a later date than oats, appearing in Central Europe at the end of the Bronze Age. Rye has been identified at only one site in Britain, viz., the Iron Age hill-fort of Hunsbury, near Northampton, dating probably from the first century B.C. But rye was the chief bread corn of north Germany and adjacent districts in the first century A.D. and it does not seem to have been much used in Britain until it was introduced by the Angles, Saxons and Jutes in the fifth century A.D. It was in common use here during the Middle Ages, but since the eighteenth century it has disappeared again as a bread corn in Britain, but is still popular with the Germans and Scandinavians. *Polygonum* is still very prominent, being responsible for 17 per cent. of all the impressions belonging to this period, and flax, which may have been a recent arrival in Denmark, provides nearly 3 per cent. of the total.

Very few impressions are available on pottery dating from the post-Roman Iron Age (A.D. 500–1000), but the few that exist are of barley, rye and *polygonum*.

In addition to the impressions which we have been considering, quantities of carbonized grain and other seeds have been discovered in the excavation of dwelling-sites of early periods in Denmark. In general they confirm the conclusions reached by Sarauw and Jessen, but they also provide evidence

that certain other plants were apparently cultivated—or at least collected and stored. Thus White Goosefoot (*Chenopodium album*) seems to have been cultivated in the Early Bronze Age, perhaps for use as a vegetable; the leaves have been used in historic times as cabbage, and the seeds have been ground with corn for bread but have a certain laxative effect. 'Gold of Pleasure' (*Camelina sativa*) was cultivated in Hungary in the Neolithic period and in Denmark in and before the Roman Iron Age; in the latter country it was used as late as the eighteenth century for flavouring bread. The seeds of this plant, which is a weed in fields of flax, contain 30 per cent. of oil which can be used either as food or for light. Corn-spurrey (*Spergula arvensis*) was cultivated in the Iron Age, as it is to-day, for fodder. Woad (*Isatis tinctoria*) was also grown in the Roman Iron Age for its blue dye. It seems to have been known in south and west Europe earlier than in central Europe, and was cultivated in Scandinavia as late as the early nineteenth century. Flax first appears in the pre-Roman Iron Age; isolated finds of linen belonging to the Neolithic and Late Bronze Ages were probably imported and not manufactured locally.

We have considered the early cultivated plants of Denmark in some detail because that country is representative of northern Europe, and because the evidence as to early Danish agriculture is relatively abundant. Unfortunately we have so far very little comparative material to show for Britain, partly because the remains of our most important early settlements have not been preserved in peat, and partly because for some reason our pre-historic pottery is not nearly so rich in impressions of seeds as is the Danish material. Only one collection of carbonized grain belonging to the Neolithic period has been found in Britain; this was discovered by the late Miss Dorothy Liddell in the Neolithic camp at Hembury (Devon), and has been identified by Professor Percival as bread-wheat. Impressions of barley have also been found on a shard of pottery from a similar camp at Whitehawk, Brighton (plate VI). These Neolithic camps are distinguished by fortifications having ditches

interrupted by frequent causeways, and while the pottery from these camps resembles that of western Europe in general, the interrupted ditches are a feature which has only been found in Germany, Belgium and southern England, thus indicating a central European origin for at least one element in this culture. It may be, therefore, that the bread-wheat found in Hembury was ultimately derived from the south-east via the Danubian route. It seems possible that grain belonging to the Neolithic culture which reached western Britain by the Atlantic route may prove to be mainly Emmer wheat, as this is particularly associated with the Megalithic culture in Denmark. Two grains of carbonized wheat resembling Emmer were found embedded in the side of an Early Bronze Age food-vessel at Hanging Grimston in the Yorkshire Wolds. On the other hand some grain found in a Middle Bronze Age burial at Pond Cairn, Coity, Glamorgan, consists probably of bread-wheat and barley. A similar specimen from a Late Bronze Age burial at Theale (Berks) has been identified as bread-wheat.

Grain from settlements of the Iron Age in Britain (500 B.C.–A.D. 43) is slightly more abundant. Whenever the species of wheat has been identified it is usually bread-wheat; in only one instance is it stated to be Emmer. Barley is relatively less common, and its varieties have seldom been differentiated. Oats, which appear in Britain for the first time during the Iron Age, are not at all common. Rye, as already stated, has been identified at only one site, viz., at Hunsbury, near Northampton. Finally, beans have been found at three sites in Somerset, including the lake-villages of Glastonbury and Meare, where they owe their preservation to their having been embedded in peat.

Since the above was written Knud Jessen and Hans Helbæk have published the results of their investigation of cereals in the British Isles in prehistoric and early historic times—work that was carried out in 1939 along lines similar to that on the Danish material already described. Their conclusions, while differing rather widely from those already published by British

botanists, are consistent with those obtained from the Danish material. According to them the principal cereals grown during the British Neolithic period were Emmer and naked barley; during the whole of the Bronze Age naked barley predominated, but husked barley took first place throughout the Iron Age right down to the Saxon period. Emmer again became important during the Early Iron Age, but bread-wheat was of small importance at any period before the Middle Ages. Flax first appears in the Middle Bronze Age, and oats, rye and spelt in the Early Iron Age.

This brief sketch will give some idea of the way in which agriculture spread to Europe, and of the principal crops which the earliest European farmers cultivated. We must now study something of their methods of tillage and of the instruments they used, and in doing this we shall have the development of British agriculture principally in view.

BOOKS AND ARTICLES

V. Gordon Childe, *The Dawn of European Civilization* (3rd Edn., 1939).
H. J. E. Peake, 'The Early Spread of Agriculture,' *Man*, 1939, 54.
E. Cecil Curwen, 'Early Agriculture in Denmark,' *Antiquity*, XII (1938), 135; 'The Early Development of Agriculture in Britain', *Proc. Prehist. Soc.*, IV (1938), 27.
Knud Jessen and Hans Helbæk, *Cereals in Great Britain and Ireland in Prehistoric and Early Historic Times* (Copenhagen, 1944).

CHAPTER V

PLOUGHS AND FIELDS

If you are going to mark out a plot for cultivation in waste land, the size and shape of that plot will be governed by the kind of instrument you propose to use for breaking up the ground.

If you are going to use a plough you will be making furrows; and so you will mark out a straight-sided rectangular area of some size, allowing sufficient length for the furrows so that you

do not waste time in turning the plough too frequently. What you may consider the most suitable length for the furrow will depend upon the power drawing the plough (other things being equal) : a small team of animals will need a shorter furrow than a large team, because they will need more frequent pauses for getting their breath, and they only get such pauses at the end of a furrow. If, on the other hand, you are going to use a tractor, you will want still longer furrows, partly because the tractor does not need to stop to get its breath, and partly because, working faster than animals, it can plough a much larger area in the same time.

Then there is another point about old wooden ploughs. If you are imbued with the once-prevailing view that your plot of ground should represent—nominally, at any rate—the amount of work that one plough-team can do in a day, the area of that plot will be more or less constant, but its shape will depend on the length of the furrow. Thus a short furrow will allow a relatively wide and squarish plot, while a long furrow will make a narrow, strip-like plot. Then again, if you are using a primitive light plough, without wheels or plough-share, which only scratches a shallow groove in the soil, it will be an advantage to have a squarish plot so that you can plough it in two directions at right angles, the better to aerate the soil. A heavier plough, possessing a plough-share that undercuts and turns over the sods, will obviate the necessity for such cross-ploughing, and being drawn by a larger team it will, on both counts, require a long furrow, and this will result in a narrow plot.

In this way we see that light ploughs drawn by small teams cultivate small, squarish plots, while heavier ploughs, drawn by larger teams, tend to be associated with narrow, strip-like plots. Tractor-ploughs, on the other hand, working faster, and being free from the old equation that the plot equals the day's work, demand fields that are very much larger, if possible, in both dimensions.

But you may be a more primitive cultivator and propose to

break up your plot of ground by hand, never having heard of a plough. You will use either a digging-stick or a hoe, and not being familiar with the furrows made by ploughs you will make no attempt to work in straight lines. In fact, you may not even trouble to mark out your plot beforehand. You will work round boulders, large tree-trunks or huts, and when you have finished your plot will be small in area and quite irregular in plan—very likely more or less round or oval.

If, however, you are doing very much the same thing in the twentieth century—breaking up ground for an allotment, in fact—you will be using a fork, and being familiar with ploughs and furrows you will work on the same orderly principle, digging in straight lines. Consequently your allotment will be rectangular in plan, but much smaller in area than a ploughed field.

We see, therefore, that given the shape and dimensions of a cultivated plot one can make a shrewd guess at the type of implement used by the man who first tilled it.

We must not imagine that the use of the plough is as ancient as agriculture itself. On the contrary, it was a comparatively late invention, as we shall see presently. Before its appearance the ground was broken up with the aid of digging-sticks or hoes—a fact which limited the amount of ground cultivated. A digging-stick was a strong, straight, pointed stick, possibly weighted with a stone (as are some modern specimens), and from it have been developed the spade, the garden fork, and perhaps the series of angular digging-sticks of which the Hebridean *caschrom* is the best-known example (fig. 7, 3). The hoe was an instrument consisting of a blade, made of hard wood, stone or metal, set at an acute angle to its handle (fig. 6, 1, 2); it was the ancestor of the mattock and the pick. Both of these implements—the digging-stick and the hoe—have survived among primitive tribes down to the present day where ploughing is not practised. This hoe-culture, as it is called, was often associated with a semi-nomadic life, unless it happened to be practised in a river-valley in which the fertility of the soil was

renewed by natural or artificial irrigation, or unless the population was stabilized by the cultivation of fruit-trees. Unless manure was used for dressing the garden-plots the fertility of the soil would be exhausted after a very few years' continuous cultivation; the plots would then be abandoned and the settlement moved to another site where fresh ground was broken up. In the irrigated valleys of the Nile and the Tigris-Euphrates such migration was not necessary, nor was it possible wherever fruit-trees were cultivated. Elsewhere, on the light soils of the uplands it was the rule, and we have an interesting literary reference to the practice in the case of the patriarch Isaac, a pastoral nomad, who 'sowed in that land, and received in the same year an hundredfold, and . . . departed thence' (Gen. xxvi, 12, 17). Hoe-blades, made of flint or chert, have been found in the remains of the predynastic cultures of both Egypt and Mesopotamia.

The earliest European farmers used hoes for breaking up the ground before they had any knowledge of the plough. The people of the Danube valley during the third millennium B.C. practised nomad agriculture, cultivating small plots with stone-bladed hoes. The same was probably true of Britain down to about 1000 B.C., and the practice of using hoes appears to have survived among some European mountain tribes as late as the beginning of our era. It even survives to-day in large parts of Africa, where, for one reason or another, the plough has not been introduced.

There was very little grassland in western Europe when the first farmers arrived. The heavier soils were covered with dense oak-forests, and the lighter soils with scrub and trees of various kinds. When, therefore, ground was broken up for cultivation, the trees and bushes would first have to be cleared by felling and burning, and then the soft leaf-mould of the clearing would be easily loosened by the flint hoes.

Striking evidence of this practice has recently been obtained in the peat of the Danish moors. Peat is formed by the growth and decay of moss, the growth of successive years accumulating

on top of the remains of that of previous years. The lowest levels of a deep peat-bog may have been formed thousands of years ago, and everything that found its way into the bog from time to time will have been preserved at the level which was the surface of the bog at the time in question. Among the things which used to find their way into the bog were sometimes tools and weapons left by man, but they also include microscopic particles such as the pollen of plants and trees, and these, owing to the acid nature of the peat, are preserved from decay indefinitely. It is by a systematic study of the relative proportions of the pollen-grains of trees at various levels in peat-bogs that it has been possible to establish a fairly consistent sequence of prevailing trees going back a few thousand years, and it has further been possible to date the various phases of this sequence by noting the levels at which characteristic, datable tools and weapons, left by man, have been found. A Danish worker, J. Iversen, has recently shown that just at the period at which it is known that agriculture was first introduced into Denmark microscopical examination of the contemporary peat shows a number of interesting features. There is, first of all, a sudden decrease in the total tree pollen, indicating that clearings were being made in the neighbouring forests. There is also a relative decrease in the pollen of oak—at that time one of the most prevalent trees—followed a little later by a relative increase in birch pollen; this shows that it was the oak forests that were being cleared, and that the clearings being soon afterwards abandoned became overgrown by the quick-growing birch. Then there were at the same level sudden increases in powdered charcoal and in the pollen of corn-field weeds, and, lastly, the first appearance of the pollen of cereals. This suggests that the forest clearings were made by burning the trees, apparently for the purpose of growing corn, and that, then as now, weeds like sorrel, mugwort and plantain gave trouble to the farmers.

Some of the plots tilled in this way by the earliest British farmers can still be traced on the moors of Devon and Cornwall

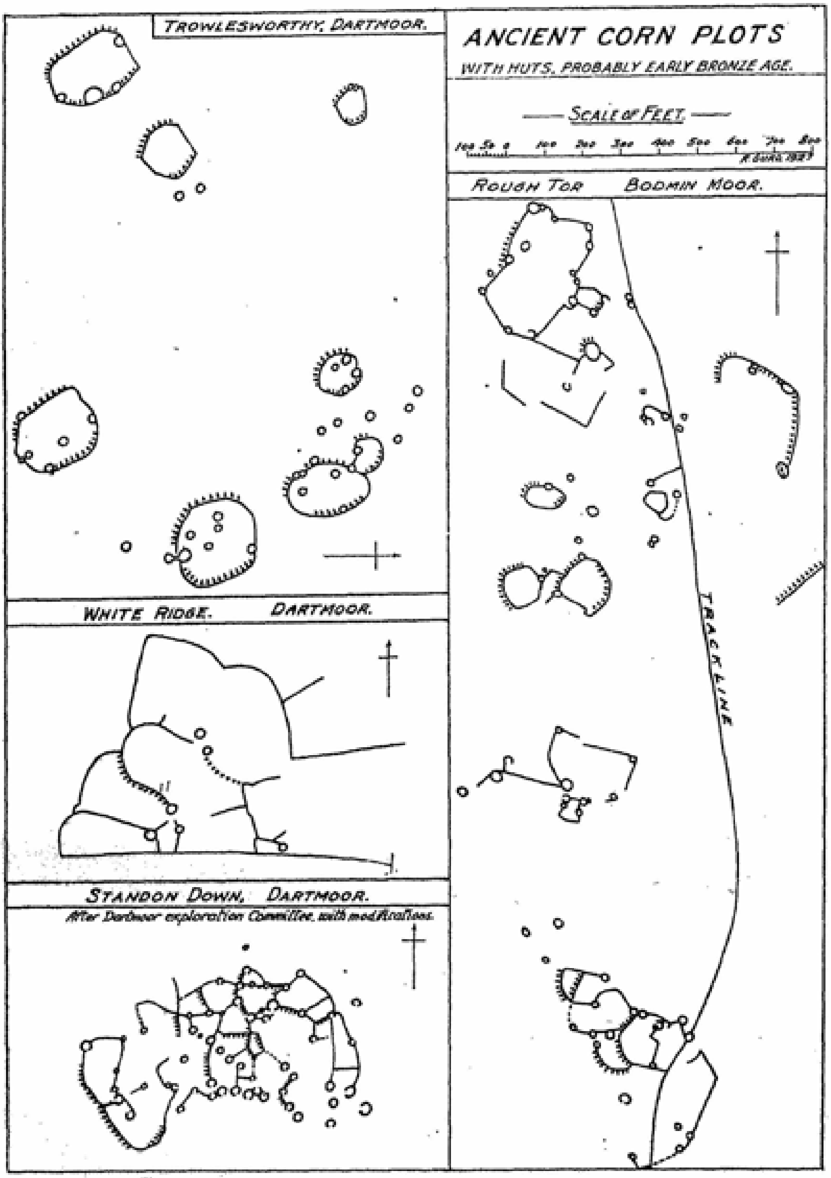


Fig. 5.—Primitive Corn-plots on Dartmoor and Bodmin Moor. The small circles represent huts.

(fig. 5). Their date is not absolutely certain as yet, but a rough estimate of 2000–1500 B.C. is not likely to be far out. Their outlines have been preserved because the edges of the plots had served as dumps for stones of all sizes which had been cleared from their surfaces, and the plots themselves are always associated with the ruins of the circular stone huts in which the people lived. How do we know that these little plots were cultivated at all, and that they were not just small enclosures for cattle or sheep? The answer is that most of them show traces of *lynchet*-formation, i.e., on sloping ground there is a tendency for the soil to be denuded at the upper edge of each plot, and to be heaped up along the lower edge. This lynchet-formation may be very slight in some cases, and quite pronounced in others, but it indicates that soil has been transferred from the upper part of the plot to the lower. This has not been done deliberately but is the result of the gradual creep of the top-soil downhill during the process of cultivation. So long as the turf remains unbroken, lynchet-formation cannot occur, and once the turf has re-formed after cultivation has ceased, the contours of the lynchets are preserved indefinitely—unless they are destroyed by modern cultivation.

Very many groups of hut-circles—the ruins of prehistoric round stone huts—are to be seen scattered over Dartmoor and Bodmin Moor. Some of them are associated with the remains of cultivated plots such as we have been considering. At one site on Dartmoor, half a mile south-east of Trowlesworthy Warren House (Shaugh Prior, Devon), there is a group of about forty hut-circles associated with eight oval enclosures (fig. 5). Most of the huts are inside the enclosures, but not all. The greater diameter of these enclosures varies from 100 to 250 feet, but the striking feature is that each is definitely lynchetted, indicating that its surface has been cultivated, but the amount of levelling so produced is not sufficient to warrant the supposition that artificial levelling had been resorted to. The indication, rather, is that the occupants of the huts tilled with their hoes an oval area round their dwellings, piling up

the stones round the edges, partly to clear them from the surface, and partly to keep the cattle from the corn. The average area of each enclosure is about half an acre, and if this represents the arable of one household, it is evident how small a part corn-growing was yet playing among those semi-nomadic people.[1]

At other sites on Dartmoor, such as White Ridge (near Postbridge) and Standon Down, near the River Tavy, small, slightly lynchetted enclosures of irregular plan are to be seen grouped contiguously in connection with hut-circles (fig. 5). At the latter site there are about fifteen plots, averaging one-third of an acre each, associated with about sixty hut-circles. The degree of lynchet-formation is less here, indicating a shorter period of cultivation. Finally, on the western slope of Rough Tor, Bodmin Moor, Cornwall, there was a long, straggling settlement of similar huts, associated with a few oval or irregular corn-plots of similar character (fig. 5). Hut-settlements with similar corn-plots, attributed to the Middle Bronze Age (1500–1000 B.C.), have also been found in north-east Yorkshire.

As one passes from the Neolithic period to the Middle Bronze Age (say, from 2000 to 1000 B.C.) in Britain, there are hints of a change in agricultural economy. A certain number of defended camps—perhaps tribal headquarters—belonging to the Neolithic period are known in southern England, each surrounded by wide areas of pastoral country on which the tribal herds must have grazed. Though these camps were contemporary with one another, the pottery found in them sometimes exhibits differences of type between one camp and the next, suggesting that communication between them must have been limited, and that pastoral nomadism must have been confined to the tribal area—perhaps as large as an English county. Grain-rubbers are of common occurrence in the camps,

[1] Confirmatory evidence that corn-growing was practised by the early people of Dartmoor is provided by the occasional discovery of a grain-rubber—a characteristic stone used for grinding corn.

showing that corn had a certain importance in the economy of the time, though it was not to be compared with the importance of stock-breeding. When we come to consider the corresponding features of the Middle Bronze Age we find that nothing resembling a permanent settlement of that period has been discovered, while the character of the pottery is the same over wide areas of the country. This betokens greater mobility of the people over wider areas, with a consequent decline in agriculture as opposed to cattle-rearing. There is thus a suggestion that towards the end of the Pastoral Stage, viz., roughly the first 1,500 years of its practice in Britain, the growing of corn may have declined very much in importance, while stock-breeding gained correspondingly.

At this point we must return to the Near East, and consider the origin of the plough.

The plough was developed as a result of the adaptation either of a digging-stick or of a hoe, so that it could be dragged continuously through the ground (figs. 6 and 7). It is not at all likely that the original invention was made independently at different times and in different places, but it is quite possible that, once the principle of traction had been established and diffused among neighbouring peoples, it was applied by some peoples to digging-sticks and by others to hoes, according to the implement which they had been accustomed to using. This would most readily account for the two principal types of primitive plough that have persisted down to the present day.

It will be well at the outset to define our terms, in order to prevent confusion. We shall for the purpose of this discussion reserve the term 'plough' for the heavy implement normally possessing wheels, coulter, share and mould-board—such as could have been seen at work a generation or two ago in England. The primitive light implement possessing none of these features we shall, for lack of an English word, distinguish by the convenient Scandinavian term *ard*.

The earliest evidence we have of the ard comes from Mesopotamian cylinder-seals and Egyptian paintings going back to

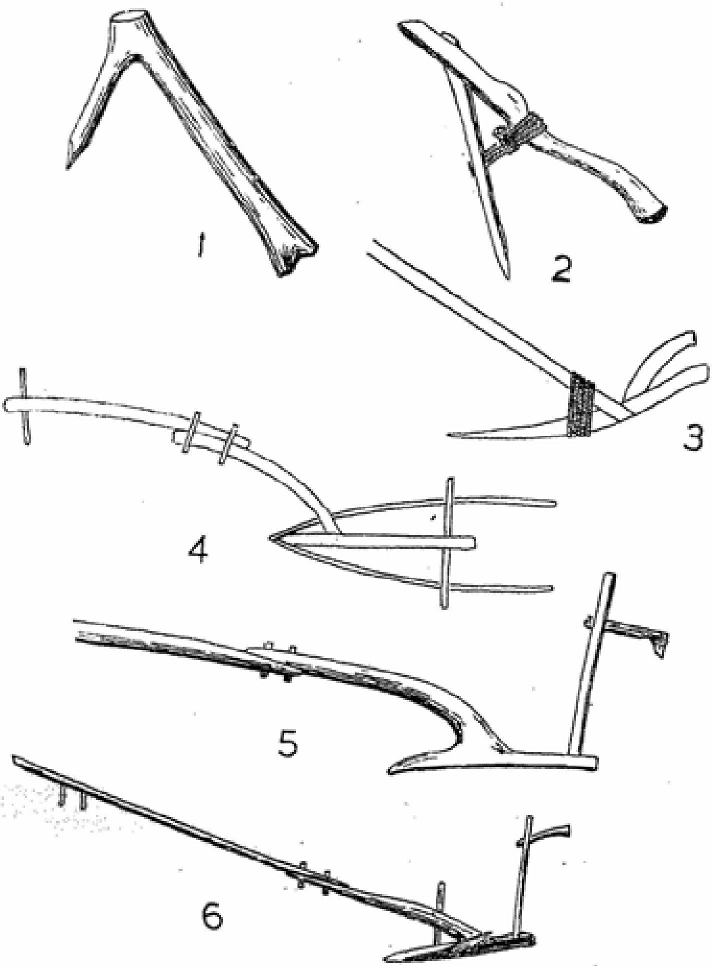


Fig. 6.—Hoes and Crook-ards. 1, Most primitive type of hoe, made from forked branch. 2, Egyptian hoe of wood. 3, Egyptian ard, apparently derived from hoe; note the two handles. 4, Sumerian crook-ard with 'ears'; no stilt visible. 5, General type of primitive Greek crook-ard. 6, Modern Cypriote crook-ard. Note jointed beams in Nos. 4, 5 and 6.

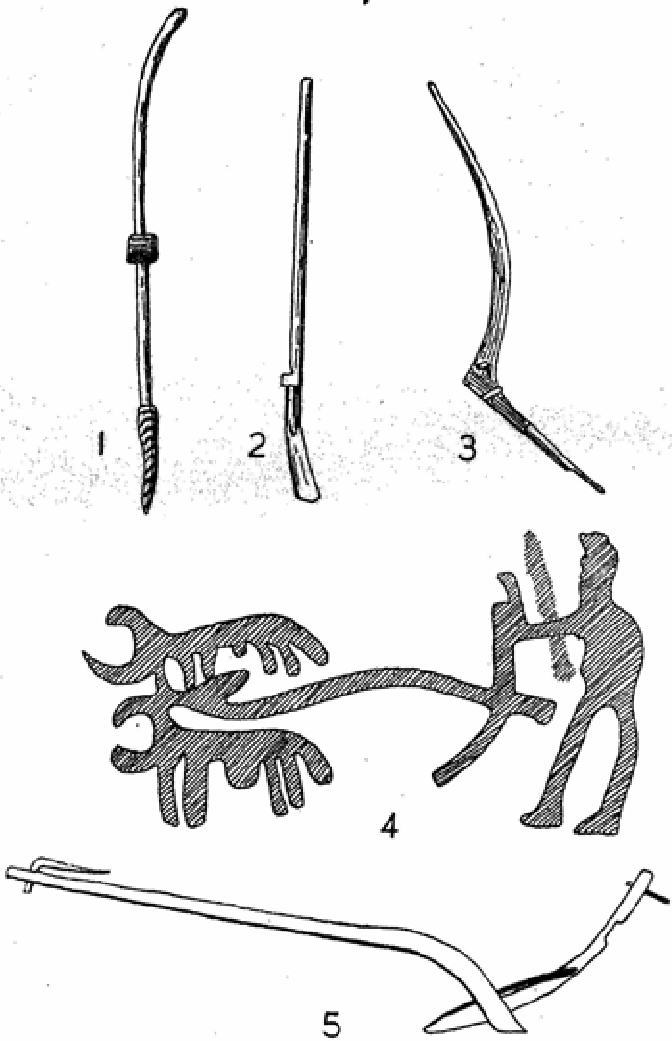


Fig. 7.—Digging-sticks and Spade-ards. 1, *Bushman digging-stick with stone weight and horn point.* 2, *Irish 'loy' (angular digging-stick).* 3, *Skye 'caschrom' (angular digging-stick).* 4, *Bronze Age rock-drawing of spade-ard drawn by two oxen; Bohuslän, Sweden.* 5, *Iron Age spade-ard of wood; Døstrup, Denmark. Length of beam,* 10 *ft.*

rather before 3000 B.C., viz., to the early Dynastic period of both regions. This suggests that it may have been, like the wheeled vehicle, a product of the industrial movement of that era. In fact, it is probably not too much to say that the ard made industrial food-production and the rise of urban culture possible, because without its help corn could scarcely have been grown on a large enough scale for export. Moreover, whereas hoe-culture was women's work, ploughing was always done by men, hence the invention of the ard is not likely to have been made by women in order to lighten their labour, for that would have involved persuading the men to take over their work altogether. It must rather have been made by men—probably by the priests, for it was anciently said that the plough was the gift of the gods—as a means of increasing the production of grain for the purposes of taxation and export. Thus the appearance of the ard is an important land-mark in the history of agricultural economy.

According to Dr. Carl W. Bishop the ard was first developed from the digging-stick in some such way as the following. The lower part of the digging-stick may already have been bent at an obtuse angle to facilitate levering up the soil, just as the blade of a spade is set at a slight inclination to the handle. A cord was then tied to the digging-stick close to this angle, and while one worker kept the point of the implement in the ground, another pulled on the cord so as to drag the point through the soil, thus producing a furrow. The next step lay with the priests who, for ceremonial purposes concerned with the fertility of the soil, caused a cow or a bull to be tied by the horns to the digging-stick and to share with the men the labour of drawing it. Any fertility it may have conferred on the soil will have been by way of manure, and it was later found that the ox was just as effective from this point of view, and a good deal steadier at pulling. In this way the practical value of ox-traction overshadowed the theoretical religious advantages, and human traction was rendered unnecessary. It may have been as a result of such experience that ox-traction

was applied to wheeled vehicles, for both the ard and the waggon appeared in Mesopotamia at approximately the same time. Somewhat later, according to the drawings, the cord was replaced by a pole or beam, one end of which was firmly attached to the digging-stick, and the other to a yoke which was tied to the animal's horns. In the simple ard thus formed the digging-stick has become the combined stilt and share-beam. A second handle was added in due course. This type of ard, derived from the digging-stick, has been called a 'spade-ard' (fig. 7).

But there is another type of ard which has been, and still is, found in widespread use; this has been called the 'crook-ard' because it has clearly been derived from a forked branch, such as was the primitive hoe, and it may be regarded as a large hoe dragged through the ground by its handle (i.e., the the pole or beam), a stilt being added at the rear for the purpose of guiding and steadying it (fig. 6). It is evident that no intermediate stage of traction by cords would have been possible in its development, so that it may have been the product of a hoe-using people who had learnt the advantages of traction from the users of the spade-ard, and who adapted the principle to their own implement.

Whether or not these views are correct, both kinds of ard spread widely over North Africa, Europe and Asia, as far as India and China. The original focus is most likely to have been in north Mesopotamia, but soon after 3000 B.C. the ard is found in Cyprus and Greece to the west, and in India to the east. It had reached the Italian Alps by about 1400 B.C. where it is depicted in a rock-drawing of the Bronze Age. Finally, it reached Britain and Scandinavia by, or soon after, 1000 B.C., while in the opposite direction it did not reach China till the third century B.C. The crook-ard was anciently used in Crete, Greece and north Germany, in which last country—at Walle in E. Friesland—a specimen has been found preserved in peat, though the early date claimed for it by its discoverer cannot be accepted. On the other hand, the spade-ard was the earliest

PLATE VII.

RELICS OF THE SQUARE-PLOT FIELD-SYSTEM, ON FYFIELD DOWN, NEAR MARLBOROUGH.

Often called the Celtic field-system in Britain; its date is not later than the Roman period

Air-photo by the late Major G. W. G. Allen.

type used in Italy, and is depicted in the rock-drawings of the Italian Alps as well as in those of Sweden (fig. 7, 4); an actual specimen of one has also been preserved in a peat-bog at Døstrup in Jutland, dated to about 400 B.C. (fig. 7, 5). Ards of one kind or another are still used in Greece and other parts of southern Europe (fig. 6, 6, and fig. 8), and occasionally in parts of Scandinavia.

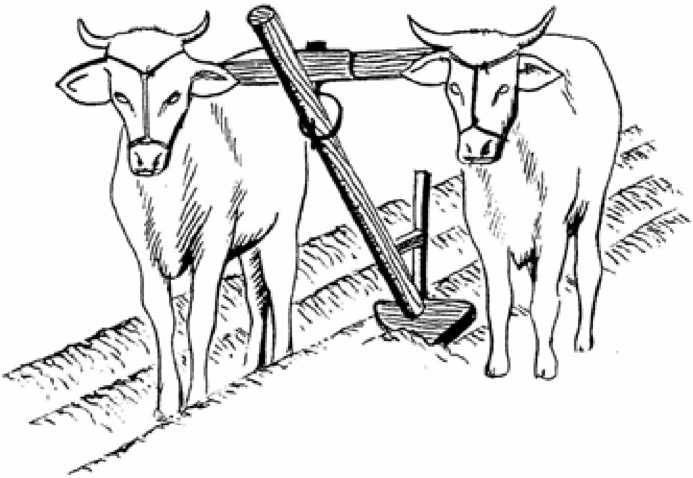


Fig. 8.—Modern Italian Ard. The triangular share-beam has the effect of two 'ears' in making a wide furrow.

Now the ard is essentially a light plough, and it is usually depicted—notably on the Alpine and Swedish rock-drawings—as being drawn by two oxen (fig. 7, 4). From what was said earlier in this chapter it will be evident that such an implement would normally be associated with short furrows and squarish plots (or small fields). This is just what we find to be the case, so that given the outlines of the fields we may legitimately infer the use of the ard.

A system of small, squarish fields, averaging a half to two acres each in area, is found in fairly general use throughout

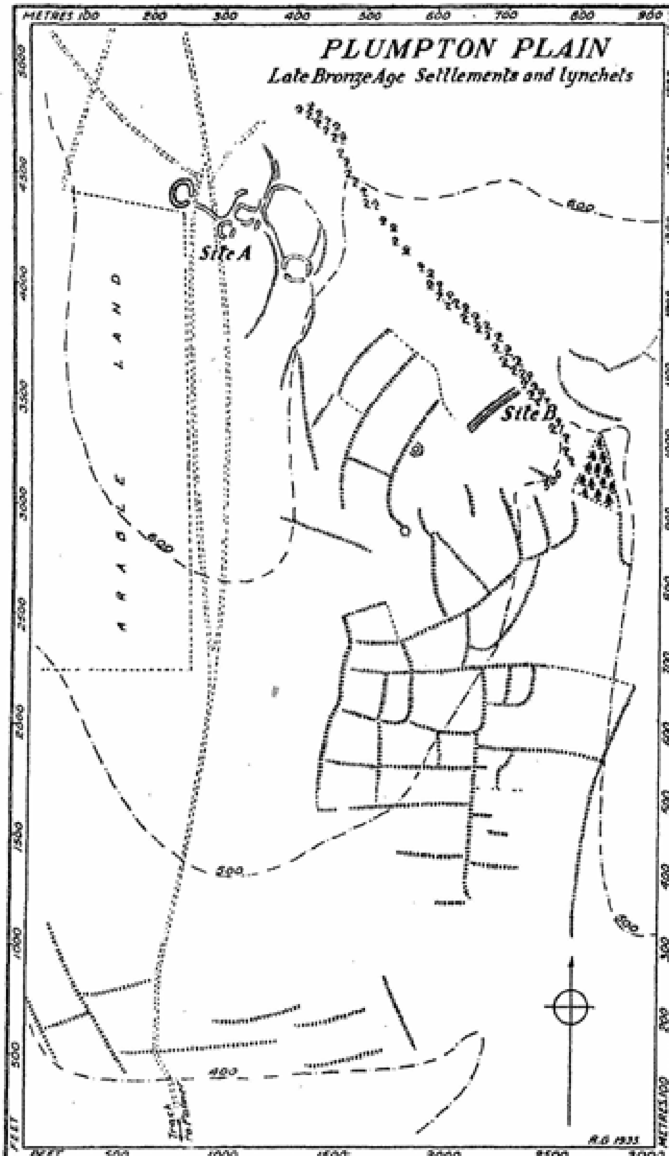


Fig. 9.—Celtic Field-System, Plumpton Plain, Sussex. This site provides the earliest evidence of the use of the ard, or two-ox plough, in Britain (c. 1000–750 B.C.).

much of Europe, especially in the south. The chief exceptions to this to-day are found in Germany, northern France and the British Isles, but this we shall consider presently. In Britain, especially on the chalk Downs of the south, there are abundant remains to show that the square-plot field system was once in general use here also (plate VII). The outlines of the plots are preserved by lynchets in the way we have already described, though in many cases these lynchets are of very great height, indicating long-continued cultivation by a settled population. The archæological evidence as to the date of this field-system is abundantly clear: it first appeared in Britain in the Late Bronze Age, about, or soon after, 1000 B.C., and it continued in use until the end of the Roman period, say, A.D. 400, after which it finally disappeared. It is doubtful whether this system was ever practised to any extent in Wales or Scotland; it seems rather that in these regions the semi-nomadic hoe-culture may have persisted down to the end of the Roman period or even later.

As far as England is concerned, this form of agricultural economy has been conveniently called the Celtic field-system, but this term will not do for Europe as a whole, for which purpose it is perhaps best called the square-plot system.

The plots of this system, delineated by lynchets, cluster round the sites of more or less permanent villages where the farming folk lived as peasants. Sometimes old roads can be traced running between the fields and into the villages, in such a way as to show that all three are beyond doubt contemporary. This is the case at Plumpton Plain on the Sussex Downs, near Brighton, where may still be seen, hidden among scrub, the remains of the earliest known specimen of this Celtic field-system (fig. 9). The pottery found in the associated settlement-site showed that the people who tilled these fields had recently come over from northern France—between 1000 and 750 B.C. —and the unmistakable shape of the fields indicates that they were tilled with the ard. This is the earliest evidence of the use of the ard in Britain. Thereafter traces of the Celtic field-system

become more plentiful, especially in the Roman period. Of the 65 square miles of downland near Brighton, for instance, lynchets of this system can still be traced covering areas totalling from 11 to 15 square miles. So much is still traceable because it has fortunately been spared destruction by medieval or modern ploughing.[1]

The use of the ard was only possible on light, well-drained soils, and in early times in Britain these were found principally on the chalk hills and on some of the valley gravels such as those of the Thames valley. All the heavier and richer soils were inevitably covered with dense oak forest, and in any case the ard was not really heavy enough to plough such soils even if the forests had been cleared. Consequently we find that the Celtic field-system was essentially an upland system, farming light soils, and based mainly on hill-villages which were connected by ridge-ways running along the backs of the ridges. In all these points this system was in marked contrast to the English field-system which followed it.

Ancient traces of the square-plot system have been found abundantly in Holland and Denmark. There is so far little or no evidence to indicate whether this was a common-field system like that of the English Middle Ages, but Professor Hatt of Copenhagen is of the opinion that it was not so, but that the plots belonged to individual owners; this is because—in the Danish examples, at any rate—there are signs of the secondary subdivision of some plots, suggesting division between heirs.

The transition from nomadic agriculture to the occupation of permanent villages and fields, such as we see in the Celtic field-system, can only have been made possible by the discovery of the value of manure as well as of the necessity for a suitable rotation of crops and for allowing the land to lie fallow periodically. This much may reasonably be inferred when we see fields bordered by lynchets 12 or more feet in height, indicating cultivation lasting over a period of centuries.

[1] This was true up to 1939, but much may have been destroyed by wartime ploughing.

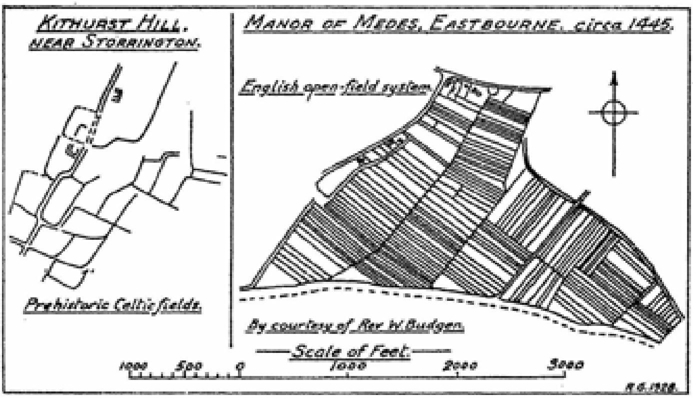


Fig. 10.—Typical specimens of the prehistoric Celtic and the medieval English Field-Systems contrasted.

Before leaving the subject of the ard we must say a word about the point of the instrument that tore up the ground. Only occasionally was this provided with wooden 'ears' to widen the furrow and throw the soil outwards on both sides (fig. 6, 4). The point itself was normally left unprotected in the earlier periods before iron became cheap. Flint points may possibly have been used in Egypt, but bronze was seldom, if ever, used for this purpose. Even in the Iron Age the point was often left unprotected: in the Danish specimen already noticed from Døstrup the point was only protected by a detachable slip of wood which bore the brunt of the wear and tear and could easily be renewed (fig. 7, 5). But when, as in Britain during the Iron Age, an iron point was used, it was not a true share, that is, it did not in any sense undercut the sods; it was nothing more than a protective 'shoe' to prevent the wood from being worn away (fig. 11, 1). The rooting effect of the point of an ard led to its being likened to the snout of a pig, so that in Greek, Latin, Celtic and Old English there are correspondences between the words for 'pig' and those for

'plough-share' or 'furrow'; this is most readily illustrated by the English words 'farrow' (=pig) and 'furrow'.[1]

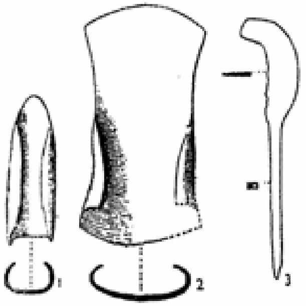


Fig. 11.—*Iron Ploughshares and Coulter.* 1, '*Shoe*' *for point of ard; Iron Age, the Caburn, Sussex* ($\frac{1}{6}$). 2, *Share for heavy Belgic plough; Bigbury, Kent* ($\frac{1}{6}$). 3, *Coulter from the same* ($\frac{1}{12}$).

About the beginning of the pre-Roman Iron Age in Denmark, i.e., about 400 B.C., the climate underwent a somewhat sudden change from the warm and dry sub-Boreal phase to the cold and wet sub-Atlantic. This change is bound to have had a profound effect on farming all over the north German plain, because for the most part that was a low-lying forested country, with comparatively little open country and light soil. The increased rainfall involved some change of natural vegetation, diminishing the available open ground that was suitable for tillage with the ard, and encouraging the growth of heather. These difficulties appear to have been met by the construction of a larger and heavier instrument, drawn by a larger team of animals, and capable of tearing up heavy, root-encumbered soils. This is the true plough, which, so far as the evidence goes, seems to have been invented somewhere between Denmark and Bavaria, and may well be one of the few contributions to civilization made by the ancient Germans.[2] The characteristic features distinguishing the plough from the ard are the wheels, the coulter, the plough-share and the mould-board. In view, however, of the fact that both implements, the plough and the

[1] Cf. Lat. *porcus*, pig, and *porca*, ridge between furrows; Celt. *soc*, pig, ploughshare; Old Eng. *fearh*, little pig, and *furh*, furrow; Gk. ὗς, pig, and ὕνις, ploughshare. This correspondence was first noticed by Plutarch.

[2] The words related to the English 'plough' are only found in Teutonic languages and seem to be applicable specifically to the heavy, wheeled plough. Throughout Europe the lighter implement without wheels is called by names derived from the root *ar*, e.g., Latin, *aratrum*.

ard, existed side by side for very many centuries, there has always been a tendency towards the production of hybrid forms that are intermediate between the two extremes, such as a plough lacking mould-board or wheels while possessing a share and a coulter. The existence of hybrids, however, tells us that both parent forms have existed also.

The earliest specimen of a heavy plough (if the dating by a recent pollen analysis may be trusted—as it should be) is a fragment that was recovered from a bog at Tømmerby in Denmark and dated to the early part of the pre-Roman Iron Age (say, fourth century B.C.). The portion preserved is no more than that which is indicated in the figure (fig. 12), but it

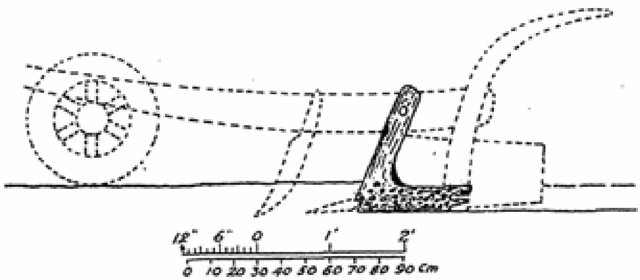


Fig. 12.—*Reconstruction of fragment of heavy Plough; Tømmerby, Denmark* (after *Steensberg*).

bears unmistakable indications of the type of plough to which it belonged, namely, a heavy wheeled plough with mould-board on the right side. The left side of the fragment was protected from wear and tear by having a number of pebbles inserted into holes drilled for the purpose; some of these pebbles, projecting from their holes, show signs of extreme wear. This device continued its use in Denmark until the eighteenth century. There is a socket for a tanged plough-share which may have been of wood, like one found in a bog at Borris in Jutland.

We have already noted that a heavy plough drawn by a large team demands a long furrow and therefore usually a narrow,

strip-like plot. Professor Hatt of Copenhagen thinks that some of the earliest effects of the invention of the plough (as opposed to the ard) may perhaps be seen in a series of square-plot cultivations at Byrsted Heath in Denmark, for mingled with the squarish plots on this site are a number of long, narrow ones, from 750 to 1,100 feet in length. This looks very much like evidence of transition from the ard to the plough.

The earliest literary reference to the wheeled plough is that of Pliny who, writing in the first century A.D., describes its use in Bavaria as something of a novelty. He also says that large teams of oxen were employed.

Let us now return to Britain. During the first century B.C. parts of southern Britain came under the influence of Belgic tribes which had spread thither from the Continent. These Belgæ were, as Cæsar tells us, of mixed German and Celtic origin, and if the heavy plough was, as it seems, a German invention, it will not surprise us to find traces of it among the relics left in Britain by these Belgæ. This is, in fact, just what we find, and, though the remains are as yet extremely scanty they are enough to constitute the earliest evidence of the existence of the heavy wheeled plough in Britain, and to suggest that it may have been introduced by the Belgæ.[1] The remains in question consist of an iron coulter and some broad-bladed iron plough-shares which were found in the Belgic fortress of Bigbury, near Canterbury (fig. 11, 2, 3), and of part of a coulter, together with traces of strip-cultivation, attributable to the Belgæ on a hill near Winchester.

During the Roman period in southern Britain two agricultural systems seem to have been practised side by side. On the one hand the native peasants continued to cultivate the light upland soils with the ard as their fathers had done before them, only much more extensively; and we have evidence suggesting that some of their surplus grain may have been required for the

[1] The Celtic word used by the Continental Belgae for the heavy plough was *carruca*, akin to Lat. *quadriga*, and signifying 'four-yoke', i.e., yoked four abreast. *Carruca* came to be widely used in medieval Latin, and has passed into modern French as *charrue*.

supply of the armies on the Scottish border or on the Continent. On the other hand, there was the system of farming associated with the Roman Villas ; of this, unfortunately, we know practically nothing, but what little we do know suggests that it may have been based on the use of the heavy plough and a system of long, narrow plots which is conveniently called strip-cultivation. In the first place, Roman villas were commonly placed in low-lying situations and on the richer soils for which the heavy plough would normally be required. A large plough-share has

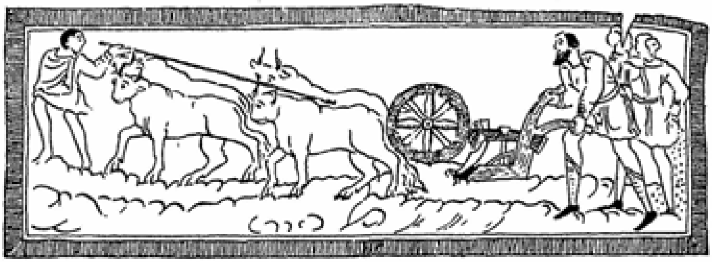


Fig. 13.—Saxon Wheeled Plough, Eleventh Century. (*Cottonian MS.*).

actually been found in one villa, and a coulter in another, while other coulters have been found among the stock-in-trade of two Roman blacksmiths. Practically no traces of the fields cultivated by the owners of the villas have survived, because, unlike the remains of the upland Celtic field-system, they have been completely obliterated by subsequent cultivation. There is, however, one site in the Fens where air-photography has revealed a group of strip-cultivations associated with the sites of two small Romano-British buildings with which they are clearly contemporary. Such evidence as there is, therefore, suggests that the agricultural system of the Roman villas may have been based on the heavy plough and strip-cultivation.

With the departure of the Romans the ard and the Celtic field-system finally ceased from southern Britain. The Angles

and Saxons brought with them the heavy plough and strip-cultivation from their Teutonic homelands, and they made their use universal in England, and ultimately throughout the British Isles (figs. 10 and 13).

Now, as compared with the ard the heavy plough was an elaborate machine, and it was drawn by a team of nominally eight, but at least four, oxen. The whole outfit was quite beyond the means of the ordinary peasant, and yet the system of agriculture which was based upon it was developed among peasant communities, without capital and without any noticeable tendencies towards industrial food-production. How was this made possible? The answer is provided by a study of the English open-field system as it existed in the Middle Ages, for there seems to be no reason to doubt that this system was essentially the same as that which the Angles and Saxons introduced. The key to the problem lies in the fact that the open-field system was a co-operative system in which all the members of the community took a share. Each peasant did not own his plough and plough-team as a modern farmer might; one had a plough, while others had one or two oxen apiece, which they contributed towards the formation of a common team, and with this they ploughed the strips belonging to each contributor in turn.

How far the medieval English open-field system may be taken as illustrating the details of Anglo-Saxon husbandry is a controversial question. The resemblances are probably more numerous than the differences, and the latter are likely to have been due in the main to the rise of the feudal system with its peculiar forms of land-tenure.

In its original conception the cultivation of the soil was based upon a unit of land known in the south of England as the *hide*, in the Danish north as the *carucate*, and in Kent as the *sullung*.[1] Each of these terms denoted a certain quantity of land; not only was it originally supposed to be the amount

[1] Carucate, from Gaulish-Latin *carruca*, a plough; sullung, from A.S. *sulh*, a plough. The derivation of 'hide' is unknown.

required to support one family, but it was especially deemed to be the amount which could be ploughed in one year by one plough drawn by a team of eight oxen. This was not a fixed measure of land but an approximation of which the exact value would depend upon many circumstances. In the same kind of way we may speak of a 'handful' of corn—a useful term for practical purposes but not an exact measure. In order to facilitate the communal ploughing to which we have already referred, and the equal apportioning of the land to all the members of the community, the arable was divided up into strips of a suitable length for ploughing. Each strip was supposed to represent the amount which could be ploughed by one plough-team in one day, and was called an *acre*. It is important to realize that the acre was first a cultivated patch before it became an abstract measure of area, just as the foot was a part of the human body before it became a measure of length. It was not until the size of the piece representing the day's work was established by statute that the acre came to have a legal length and breadth, and therefore ultimately to become a unit of area. Actually its customary dimensions varied in different districts, but it always had a length and a breadth, and was never conceived of as a measure of shapeless area. When it came to be standardized by Edward I, its length was 40 rods (i.e., one furlong, or furrow-length), and its breadth 4 rods, the rod being the goad with which the ploughman prodded his oxen. A half-acre had the same length (40 rods) but half the width (2 rods). This ratio of length and breadth had been customary for centuries, but the length of the rod had been very variable—anything from 10 ft. to 24 ft. in different districts. The statute rod was now to be 16½ ft., or 5½ yards.

We have, therefore, in early times two rough and ready quantities—the acre, representing a day's work for a plough-team, and the hide, carucate or sullung, representing a year's work. It was natural that an attempt should be made to establish a relation between these in order to facilitate land-

distribution, and especially taxation. Consequently we find that the hide was considered to be the equivalent of 120 acre-strips, but it must be remembered that this relationship was only nominal and was not always adhered to in practice. Actually the hide came to be a purely fiscal unit, bearing less and less resemblance to real land-measures.

In the north of England the carucate was divided into 8 *bovates* or ox-gangs, which meant that for purposes of taxation and communal ploughing 15 acres (1 bovate) went to the owner of each ox that was contributed to the plough-team. Similarly in the south the hide was divided into four *virgates* or yard-lands, and the sullung into four yokes, each of which (30 acres) corresponded to a pair of oxen in the plough-team. In the Middle Ages we find that a virgate, rather than a hide, was the normal holding for an ordinary peasant, which means that such a man would contribute two oxen towards the communal plough-team. If he could only contribute one ox he was entitled to the produce of only half a virgate (or a bovate in the north), i.e., 15 acres. If he had no oxen, he would probably be a cottier (or cottager), and would work as a labourer, though he might be allowed five acres in some cases.

The arable land, therefore, was held in common, and being permanently divided into acre-strips, was readily apportioned among those of the community who were entitled to it. Now if four men, A, B, C and D, each contributed two oxen to the common plough-team, they would each be entitled to one virgate of land, viz., 30 acres. They would plough all the acre-strips in turn, but A would have the first strip, B would have the second, and so on. Consequently each man's holdings would be scattered all over the available arable in thirty different parts of the common field.

Whatever may have been the arrangement of land-tenure among the earliest Saxon settlers, by the time of the Domesday Survey in 1086 we find the manorial system firmly established. A manor was a territorial unit—an estate belonging either to the king or to a lord or to the church, with a village community

in serfdom upon it. The land of the manor was divided into two parts—the lord's demesne, and the land in villenage. The former was the home-farm of the lord of the manor; the latter was occupied by tenants at customary services. The tenants, called by the Normans *villeins*, were serfs, i.e., they were not slaves, and yet they were not wholly free. They had to cultivate their land and they were not allowed to leave it without the permission of the lord; nor were they allowed to sell an ox or to marry without his consent. Besides rendering to him annually a stated amount of their produce by way of rent, they were bound to put in a specified number of days' labour on his demesne and to perform certain specified tasks, including military service. Sometimes money payments were also due to the lord, and with the subsequent decay of the feudal system all the services came to be commuted for payments in cash.

In the Middle Ages we find the land of a manor—apart from the necessary pasture and woodland—divided, sometimes into two, sometimes into three, *fields* of very great size.[1] All the tenants would hold an equal number of acre or half-acre strips in each field, scattered about in the manner described. Thus in a three-field system the holder of a virgate would have ten acre-strips in each field, i.e., thirty in all. The three fields were tilled in rotation, one being under winter-wheat, one under barley, oats or beans, and one fallow. The one under wheat this year will have barley, oats or beans next year, and will lie fallow the year after. After the harvest, and throughout the year on the fallow field, the animals were turned loose on the fields to manure them. Within each field the acre-strips were grouped in parallel bundles called furlongs or *shotts*; the strips in one shott frequently lying at right angles with those in the neighbouring shotts. Access to each strip was obtained through

[1] H. L. Gray has shown that the two-field and three-field systems are characteristic of only part of England, viz., those parts roughly corresponding to the Anglo-Saxon kingdoms of Wessex, Sussex, Mercia and the part of Northumbria known as Deira. Elsewhere other systems were generally used. He also believes that the three-field system was developed from the two-field system in the midlands during the thirteenth and fourteenth centuries (*English Field Systems*, 403, *ff.*).

the headland, which was a strip in each shott lying across the ends of the other strips. The headland was ploughed last, after all the other strips had been ploughed (fig. 10).

In due course the feudal system decayed, but the open-field system lingered on, outliving its usefulness. As an instrument of purely peasant economy it had served well enough, but now great changes were in the air. The new freedom was being born, and men were beginning to chafe under the cast-iron rigidity of the old system. Above all, in the eighteenth century the coming Industrial Revolution was already casting its shadow, and the days of a self-supporting peasantry were ending. The need for agriculture on a commercial scale was beginning to be felt, and for this there was no room within the framework of the ancient system, in which time and energy were wasted in getting about between the scattered strips. As far back as the sixteenth century men were beginning to realise that time-honoured methods of husbandry could be improved upon, and so we find that from that time there was a tendency towards the enclosure of the open fields.[1] This culminated in a series of Enclosure Acts which were passed between 1760 and 1844, whereby the old 'fields' were divided and enclosed by hedges, so that each tenant exchanged his scattered strips for enclosed blocks of equivalent area. This meant in most cases that hedges were planted round the shotts which thus correspond to a large extent with our modern fields; in the lowlands it will be noticed that in the majority of cases one dimension of a modern field is approximately a furlong, i.e., the length of an acre-strip. In parts of England, especially the Midlands, the surfaces of fields now under grass frequently undulate in a series of regular waves; these are ridges or 'lands' formed by ploughing under the open-field system; two, three or four of such ridges together went to form each acre-strip, their purpose being to facilitate drainage of the soil[2] (plate VIII).

[1] The sixteenth century enclosures affected principally the south-eastern and western parts of England where the two-field and three-field systems were not in vogue (H. L. Gray, *op. cit.*).

[2] For an explanation of the way in which these ridges have been formed by ploughing, see C. S. Orwin, *The Open Fields*.

PLATE VIII.

RIDGES OF THE ENGLISH OPEN-FIELD SYSTEM ON GREDENTON HILL, FENNY COMPTON, WARWICKSHIRE.

A relic of former strip-cultivation.

Air-photo by the late Major G. W. G. Allen

The re-arrangement of the land under the Enclosure Acts set free the potential energy of private enterprise, and made modern methods of farming possible. Without it food-production on a commercial scale, as part of an industrial system, could not have been carried on at all. The Enclosure Acts therefore led up to the Industrial Revolution, and enabled farming to benefit by the new scientific methods that accompanied that revolution.

We have said that the earlier Celtic field-system does not seem to have reached Wales or Scotland, and that even as late as the Roman period the old hoe-culture seems to have survived there. As far as Wales is concerned this is strikingly confirmed by an old Welsh tradition which states that a certain Elldud in the time of Theodosius taught the Welsh 'the system and art of cultivating land as is used at present, for before that time land was cultivated only with the hoe and foot-plough, after the manner of the Irish.' The foot-plough, which is an improved digging-stick, survives in Ireland and in the Hebrides to this day, and is an instrument of great interest, but there is considerable uncertainty as to its origin and significance (fig. 7, 2, 3). The system of cultivation in vogue in Wales when the above tradition took shape was presumably that which is described in detail in the early Welsh laws (tenth century) ; this resembles the English system in being based on the use of the heavy plough drawn by eight oxen, and on strip-cultivations with communal ploughing. It is thus reasonable to infer that the Welsh, not having been acquainted with the Celtic field-system as practised in Roman Britain, learnt the art of plough-cultivation from the Angles and Saxons, from whom they received the heavy plough and the system of co-operative ploughing, and that they then adapted these to the social structure of their own tribal system. It is quite clear that it is futile to expect to learn from any Welsh source what the system of agriculture in Roman Britain was like, for the Welsh seem never to have shared that system. Moreover, even if, as is quite likely, there were resemblances between the systems of the Roman villa and of the English manor, it is evident that

the latter could not have been in any way derived from the former, as most of the villas had been destroyed by Saxon raiders at least a century before the English began to settle. It is, however, possible that the English system may have been in part derived from that of the Roman villas on the Continent, as originally suggested by Professor Seebohm, but a discussion of this question would lead us beyond the limits of our subject.

In Scotland and Ireland a form of open-field cultivation known as the run-rig system was in operation during the Middle Ages. It seems evident that, like the Welsh system, this must have been derived in its main outlines from the English, and adapted to the social structure of the local tribal systems.

Before leaving this subject it will be interesting to quote Professor Maitland's estimate of the output of agriculture in Norman England.[1] According to the Domesday Survey of 1086 there were in England, south of Yorkshire and Cheshire, some 9,000,000 acres of arable land, and about 275,000 men to till them with 75,000 plough-teams. This suggests an estimated population of 1,375,000 souls. Walter of Henley, an agricultural reformer of the thirteenth century, considered that an acre sown with two bushels of wheat should yield ten bushels in a good year. But the population had to live, even in bad years, so Maitland takes as his basis a yield as low as 6 bushels per acre. If, then, some 5,000,000 acres were sown in any one year, and if two bushels per acre were reserved for seed, the total yield available for food would be 20 million bushels, or, say, 15 bushels per person. But a large proportion of this grain, perhaps as much as a third, was consumed in the form of beer rather than bread, and from the figures available in the records Maitland calculates that the average consumption of beer, made of oats, barley and wheat, may have been about half a gallon per head every day of the year. In the twelfth century the allowance of beer for the Canons of St. Paul's Cathedral was no less than 30 gallons per head per week! This figure represents a consumption of 24 bushels of grain per head annually.

[1] F. W. Maitland, *Domesday Book and Beyond* (1921), 437–41.

BOOKS AND ARTICLES

E. Cecil Curwen, 'The Early Development of Agriculture in Britain,', *Proc. Prehist. Soc.* IV (1938), 27; *Air-Photography and the Evolution of the Corn-field* (Economic Hist. Soc. pamphlet No. 2), London, 1938; 'Sussex Lynchets and Associated Fieldways', *Sussex Arch. Coll.*, LXIV (1923), 1; 'Ancient Cultivations', *Antiquity*, VI (1932), 389; 'Early Agriculture in Denmark', *Antiquity*, XII (1938), 135.

O. G. S. Crawford, *Air-Survey and Archaeology* (Ordnance Survey Professional Papers, N.S., No. 7), 1924 and 1928.

O. G. S. Crawford and A. Keiller, *Wessex from the Air*, Oxford, 1928.

G. A. Holleyman, 'The Celtic Field-system in South Britain: a Survey of the Brighton District', *Antiquity*, IX (1935), 443.

'Report on Lynchets and Grass Ridges' (Rep. of the 39th Congress of Arch. Socs., London, 1932), 30–5, 41–6.

C. W. Bishop, 'The Origin and Early Diffusion of the Traction-Plough', *Antiquity*, X (1936), 261.

Axel Steensberg, 'North-west European Plough-types', *Acta Archaeologica*, VII (Copenhagen, 1937), 244.

A. S. F. Gow, 'The Ancient Plough', *Journ. Hellenic Studies*, XXXIV (1914), 249.

F. Seebohm, *The English Village Community*, London, 1915.

H. L. Gray, *English Field Systems*, Harvard, 1915.

M. E. Seebohm, *The Evolution of the English Farm*, London, 1927.

C. S. Orwin, *The Open Fields*, Oxford, 1938.

J. Iversen, 'Land Occupation in Denmark's Stone Age', *Danmarks Geologiske Undersøgelse*, II Række, nr. 65 (Copenhagen, 1941).

CHAPTER VI

PASTURE

We have already seen that the two parallel forms of food-production—pastoralism and agriculture—appear to have arisen more or less simultaneously somewhere within an area bounded on the west by the River Nile, on the east by the River Indus, and on the north by the forty-fifth parallel. We have also suggested that these two forms of food-production may have been practised at first by two distinct sets of people, leading quite different lives. Those who tilled patches in the irrigated river-valleys were sedentary, and therefore had time to develop science and the arts, while those who tended flocks and herds had to lead a nomadic life, wandering ever in search of fresh

pastures. The life of a nomad affords plenty of opportunity for meditation, but little for experiment, hence the contribution made to civilization by pastoralists has been in the realm of philosophy, religion and oral literature rather than in that of material advancement.

Contacts between the two groups must have been frequent and regular, being afforded by the migrations of the pastoralists. Jealousies there may have been, as is suggested by the ancient story of Cain and Abel, and the hardy nomads no doubt despised the sedentary farmers, and considered their work drudgery. But the herdsmen must have supplied the farmers with meat, the bones of which we find in the excavation of the earliest cities, and in return the cultivators supplied the nomads with grain. The herdsmen may also have acted as traders of other goods that came from a distance, and in this way they may have played a part in the early spread of agriculture.

By the time that the knowledge of food-production began to spread into Europe we find evidence that its two forms—pastoralism and agriculture—were both being practised together by the same people in those regions. We have already seen that, with the exception of those who were tied to the soil by the cultivation of fruit-trees, the earliest European farmers were pastoralists who practised nomad agriculture, only staying in one place long enough to till their small patches of wheat and barley, and then moving onto another district. The relative importance of the two activities did, however, vary; while the Danubians were nomadic cultivators who bred some cattle, the earliest British farmers were first and foremost herdsmen, and such evidence as is available suggests that their agriculture played a relatively small part in their economy. Their wealth lay in cattle; this was the hub of their life. Sheep, goats and pigs were much less important; wheat and barley were mere garden-produce.

The habits of pastoral tribes vary much with circumstances of all kinds. They can be studied to-day in those regions where nomad herdsmen still roam, especially on the steppes

and tundras of Asia, and in parts of Africa. Those habits which are common to nearly all such peoples can safely be attributed to the prehistoric herdsmen of western Europe too. Thus their social organization is formed on a patriarchal basis, like that of the Old Testament patriarchs. Families form clans, and clans form tribes, with chieftains at their heads. Land is owned by the whole tribe and is carefully distinguished from land belonging to other tribes; the migrations are normally limited to the tribal area, and regular camping-grounds are revisited in rotation. Some of the Celtic peoples, such as the Welsh and Irish, retained traces of some such organization as this down to historic times; this is because their economy remained predominantly pastoral to a later date than that of many other European peoples.

Migratory habits necessitate light, portable dwellings such as tents or wigwams, though in stone-bearing districts stone huts may have been constructed at regular camping-grounds and periodically revisited. As a rule, however, portable dwellings leave practically no trace behind them, perhaps not even post-holes in the ground by which archæologists can trace them. Moreover, the personal effects of such people are few, light and unbreakable.[1] Thus gold ornaments are popular because they can easily be carried and yet make a brave display, while pottery vessels are seldom used because of their weight and fragility. Among the most permanent remains of nomad people are their graves—the only permanent home they know—and these tend to compensate by their size and splendour for the lack of other abiding features in their life. Thus the people of the British Middle Bronze Age are known almost exclusively from the grave-mounds, or barrows, which they left as conspicuous memorials beside the upland trails along which they were wont to drive their cattle. Hardly any of their habitation-sites are known, unless they were in those scattered spots on the chalk Downs where flint implements are found in special abundance.

[1] It is interesting to note that the words 'chattel', 'cattle' and 'capital' are really three forms of the same word, all signifying 'possessions'.

When we use the term pasture in reference to prehistoric Europe we must not think of open, rolling grass-lands, still less of enclosed meadows. Dr. Grahame Clark has recently pointed out that in prehistoric times western Europe was almost entirely covered with forest and scrub, varying according to the nature of the subsoil; any grass-land that existed must have been very limited, being largely the result of human activity in tree-felling, and perhaps of the destruction of scrub by grazing cattle. After all, the original wild ox—the urus—was a denizen of the forest, and we do not always realize that cattle, and probably sheep also, can graze in woodlands and scrub as well as on grass-lands.

The diffusion of the ard (light plough), together, presumably, with some experience of the value of manure in restoring fertility to the fields, gave a great stimulus to agriculture as contrasted with pastoralism. Much more land came under cultivation and permanent settlements sprang up. Migration was limited because the capital that was now sunk in the soil could not be lightly thrown away by abandoning fields that had been tilled with such labour. With the increasing importance of corn there was less need to keep such large flocks and herds as to necessitate the frequent search for fresh pastures. The stock was, in fact, limited to the number of beasts that could be grazed on the pastures and waste lands surrounding the village. This was supplemented by allowing the animals to feed on the stubble after the harvest, which not only helped to fatten the beasts, but ensured that the fields received the necessary manure.

Provided that the climate is suitable the herds can be left in the open in winter as well as in summer, and the warm, dry phase of the climate of the British Middle Bronze Age probably allowed of this. But about the beginning of the Iron Age (say, 500–400 B.C.) a sudden deterioration of the climate set in, bringing in a prolonged phase of cold, wet weather. Coinciding as this did, with the diffusion of cheap iron tools for the first time, this change in the climate must have wrought a corres-

ponding change in herding life. The houses of this period that have been excavated in Denmark were long, narrow buildings, of which one end served as a cow-byre, as may be seen in some of the houses in the Hebrides even at the present day.[1] The significance of this observation lies in the indication it gives that beasts were normally stalled in winter, and therefore that their numbers must have been limited to those that could be accommodated in byres. A further inference is that artificial feeding must have been resorted to in winter. This in its turn was facilitated by the use of iron which made it possible for farmers to have new and larger implements to meet the new needs. Thus we now find two implements appearing for the first time—both developed from the time-honoured sickle for special purposes: one was a slasher or leaf-knife which was used for stripping leaves from the trees for use as fodder; the other was the scythe, used for cutting hay for winter feeding.

In certain parts of Europe where geographical features admit, a modified form of nomadism, called transhumance, has survived down to the present day. This consists in the annual migration of some or all of the occupants of a village with their herds from their permanent homes to spend the summer months on the upland pastures. This has been regarded, rightly or wrongly, as a relic of nomadism, modified and reduced in scope by increase of population and consequent scarcity of land. Instead of visiting, say, a dozen camping-sites in rotation, spread over a wide area, only two sites are occupied, the winter village alternating with the summer pastures. But the factors which have caused this system to survive at all in Europe are geographical, and include the presence of moors or mountains together with a sparse population occupying the lowest available land and engaged in agriculture of peasant type. These conditions are found in Norway, Switzerland, the Balkans, Italy and Spain, where the annual migration to the summer pastures

[1] It is not suggested that cow-byres were never used at an earlier date; they were used, for instance, in the Shetlands in the Middle Bronze Age, and in the Neolithic Alpine lake-villages.

is a well-known feature, the herders living a simple life in wooden huts among the mountains, milking the cattle and making cheeses. The same practice was once prevalent in the mountainous parts of Britain and Ireland; evidence of this is found on the Scottish border wherever a place-name is found containing the element 'shiel' or 'shield', for a shieling was a hut or group of huts in which the people lived while up on the summer pastures. Many such places have since become farms, villages, or even towns. Similarly in south-west Scotland place-names occur containing the element 'airy' (spelt in various ways); this represents the Gaelic word for a shieling.[1] Thomas Pennant, who toured Scotland in 1769, found shielings in use in Glen Tilt in Perthshire; the hut was built of turf (peat), and the furniture consisted of milking-utensils and horn spoons; a row of sods and a rug formed the bed.[2] The occupants lived on oat-cakes, butter and cheese, and also cow's blood spread on bannocks. As late as 1859 groups of bee-hive-shaped huts, built of dry stone without mortar, were occupied as shielings by the people of the western part of the Isle of Lewis in the Hebrides; turf covered the outsides of the huts, and the only openings consisted of one or two doors, about two ft. high, and a hole at the summit to let the smoke out. Two or three women occupied each hut, and there were shelters also for calves and lambs.[3] This type of dwelling is very ancient, and the ease with which the occupants could disappear into seemingly natural hillocks may have given rise to the beliefs about fairies dwelling 'in the hollow hills'.

The Isle of Lewis is the only part of Britain in which the habit of migrating to summer pastures is still practised at the present day. The old beehive huts have mostly vanished, and the modern shieling consists of a group of rectangular huts with gable-ends, solidly built of blocks of peat. This kind of

[1] In Welsh place-names *Hafod* has the same meaning.

[2] T. Pennant, *A Tour in Scotland* (3rd Edn., 1774), I, 108.

[3] Comdr. F. W. L. Thomas, R.N., in *Proc. Soc. Antiquaries of Scotland*, III (1862), 127.

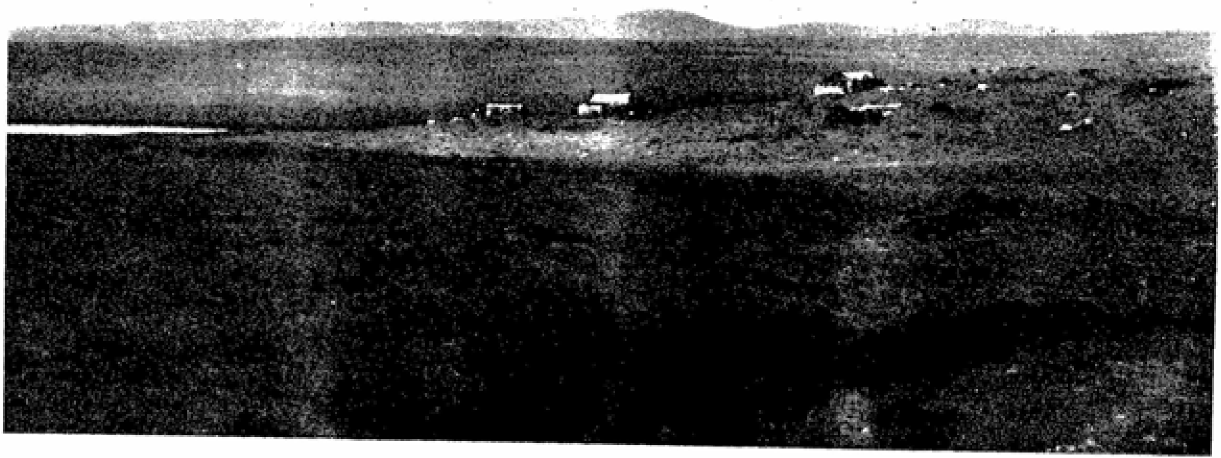


PLATE IX.—A SHIELING IN THE ISLE OF LEWIS.

During the summer months the women live here on the moors, tending and milking the cattle.

Ph.: E.C.C.

hut, which will last for several years, has been made possible by the advent of motor transport which enables the occupants to bring a temporary roof with them, made of boards and tarpaulins, and to take it home again at the end of the summer (plate X). In the olden days everything which was needed at the shieling had to be carried on ponies' backs; now they can bring out bedsteads and other luxuries, and they may even line the turf walls with paper.

The departure for the shielings takes place in June, after the spring corn has been sown in the village, and the event used to be celebrated with a kind of festival. 'At an early hour in the morning the procession formed, the men, lads and young girls driving the sheep, mares and calves, their simple provision packed in creels strapped on the backs of a few mountain ponies, the older women, knitting as they walked, following with the young children. . . . On arriving there would be small repairs to make to the shielings of last year. . . . When all was arranged they would sit down in scattered groups to the Moving Feast'.[1] The men then returned to the village, leaving the women and girls to look after the cattle. The return from the shielings takes place in time for the harvest.

In the English Open-Field System, which was briefly described in the last chapter, provision was made for the adequate grazing of stock. A certain amount of the area of the 'fields' was meadowland which was sometimes marked out in strips to facilitate the allotment of hay to individual tenants for winter-feeding. The bulk of the grazing was done on the common-land outside the field, and in order to ensure fair apportionment each tenant was only allowed to keep a number of beasts proportionate to the extent of his holding. As has already been stated, the animals were folded on the stubble after harvest, and throughout the year on the fallow field. When land was assessed as being the amount which one plough-team of eight oxen could plough in one year, the amount was

1. A Goodrich Freer, *Outer Isles* (1902), 161.

held to include sufficient pasture or pasture-rights to support the eight ploughing oxen.

In Saxon times pigs were the principal source of meat, cattle being kept chiefly for milk, butter and cheese and as draught-oxen, and sheep being kept for their wool and their milk. As late as the thirteenth century pigs were turned into the woodlands to graze in autumn under the care of a swine-herd; there they sustained themselves on beech-mast and acorns. These animals are characteristic of settled communities; nomads do not keep many pigs as they are not able to stand being driven long distances like cattle.

Before the advent of modern methods of feeding the great difficulty of the medieval farmer was to feed his cattle in winter. Hay was scarce, and fattening foods non-existent, so recourse was sometimes had to collecting leaves from trees. In any case the beasts were miserably underfed and would have made a poor show according to modern standards. The problem was only solved at all by the practice of killing off the bulk of the stock in autumn, salting the meat for winter use, and preserving only breeding-stock, draught-oxen, and sufficient of the young to replace losses.

When the common fields were enclosed, and after much arable land had reverted to pasture, the English countryside took on the appearance which it has to-day. Many commons were also cut up and enclosed, and the result has been that cattle and sheep are now pastured in private enclosed meadows in the lowland parts of England. On the open rolling hills sheep still feed, either at will, as in the north, or in flocks under the charge of a shepherd and his dog, as on the South Downs. But wire fences are depriving shepherds of their jobs, and before long, like the medieval cow-herd and swine-herd, he will be no more.

Owing to the development of science during the last two centuries, and the consequent improvement in methods of breeding and feeding, modern stock-raising differs as much from that of medieval times as does modern agriculture. The

Plate X.—A Hebridean Shieling with its Occupants.

The hut is built of blocks of peat, and the roof, consisting of boards and tarpaulin, is removed at the end of the summer.

Ph. : E.C.C.

underlying reason for this is the stimulus afforded by competitive commerce. No longer does the peasant rear animals merely for his own use or for his lord; a minority of the population breeds them on a large scale for profit in one form or another. This is industrial food-production, the advent of which has changed the face of the civilized world almost as much as did the original 'discovery' of agriculture.

BOOKS AND ARTICLES

C. Daryll Forde, *Habitat, Economy and Society* (1934).
E. H. Carrier, *Water and Grass* (Christophers, 1932).
E. Estyn Evans, 'Transhumance in Europe', *Geography*, XXV (1940), 172.
Elwyn Davies, 'The Patterns of Transhumance in Europe,', *Geography*, XXVI (1941), 155.

CHAPTER VII

REAPING AND THRESHING

Our account of the early development of agriculture will not be complete without some consideration of the methods employed in dealing with the grain which has been produced by tilling the ground. This grain must be harvested, threshed, dried, and finally ground to meal before it can be satisfactorily used as food. All these processes have undergone variations and development among different peoples and at different periods. As it would be easy to become bewildered by masses of detail in this study, we shall confine ourselves to the more outstanding features and a general consideration of principles.

If you have before you a crop of ripe standing corn there are, broadly speaking, two ways in which you can harvest it: you may pull it up by the roots, or you may sever the straw with a sharp-edged implement somewhere between the root and the ear. Much will depend upon whether the straw is useful to you as well as the grain, for if you are interested only in the grain you (being, we will suppose, a primitive farmer) will probably cut off the ears and leave most of the straw to be

consumed by animals or to be ploughed into the ground. Primitive people do not always act in such a manner as to economise labour, and after cutting off the ears they may actually return to sever the straw close to the root.

It is known that uprooting has been practised by primitive peoples here and there within historical times, but it cannot be regarded as the normal forerunner of cutting, because recognizable flint reaping-knives or sickles go back earlier in time than agriculture itself, as we saw in Chapter II.

Generally speaking, the more primitive a culture is, the fewer are the kinds of tools used, and each kind of tool is put to a wider range of uses. The proverbial schoolboy's knife provides a partial analogy, for it is apt to serve a variety of purposes that were never intended by the maker. Thus any flint implement that served the purposes of a knife would be used for cutting all kinds of things, and the same implement might well be used for woodwork, for cutting meat or bone, and for harvesting grain. It is only as cultural development proceeds that distinct varieties of knife are made to serve these different purposes. How then can we be certain that any given implement of this kind was actually used for cutting corn? This is how we can tell.

Silica is a substance that enters very largely into the composition of soil and rocks, including flint itself; it is exceedingly hard, and under certain conditions of friction it can impart to a piece of flint a very brilliant lustre or gloss. Indeed it is probably the only substance within the experience of primitive man that is capable of polishing flint.

Now silica from the soil is absorbed into the tissues of certain members of the vegetable kingdom, including especially certain grasses and hardwood trees; it is this, for instance, that causes a blade of Pampas grass to cut your hand if you handle it the wrong way. On the other hand, silica is not found in the bones or soft tissues of man or domesticated animals or beasts of the chase, but it is abundantly present in the straw of those grasses which we know as wheat and barley, as well

as of other grasses. Consequently any sharp flint which has undergone prolonged use in cutting corn or other grasses tends to acquire a more or less brilliant polish which extends for some distance back from the cutting edge (plate XI, 3, 4). A flint knife or 'saw' cannot be used for cutting deeply into wood, but only for paring the surface or making nicks round a stick with a view to breaking it across. Therefore a flint that has been used for this purpose may show a narrow band of lustre along the cutting edge, quite distinct from the deep band of diffuse gloss produced by cutting a yielding substance like straw. But a flint that has seen prolonged use in nicking or carving bone shows no lustre at all, because bone contains no silica.

Besides this, sharp-edged flints showing the kind of gloss that comes as a result of cutting corn have only been found among the remains of peoples who are known to have practised agriculture—with one important exception. This strongly supports the view that they were actually used for cutting corn, rather than grass or rushes. The exception referred to really confirms this too, because it refers to the case of the Natufians of Mount Carmel in Palestine, who, though as far as we can see ignorant of agriculture, and subsisting on the wild products of nature, lived in an area in which the wild parents of wheat and barley almost certainly grew (see Chapter II). In other areas there was no occasion for food-gathering peoples to cut siliceous vegetable matter with flint knives, and so we do not expect to find such glossy flints among their remains, and in fact we do not find them. It seems, therefore, reasonably certain that the presence of diffuse gloss on the edge of a flint indicates that that flint has been used for cutting corn. Naturally it takes a considerable amount of use to produce this gloss, and flints that have not seen much use will not show it, so that the absence of gloss proves nothing.[1]

The Natufian flint reaping-knives or sickles which, as we have already noted, are the earliest known specimens of their

[1] The above conclusions are supported by the results of experiments described in *Antiquity*, IV (1930), 184; IX (1935), 62.

kind, consisted of a row of neatly-shaped flint flakes set end-to-end in a groove along one edge of a more or less straight bone handle (fig. 2, 1). Many of the flakes show the characteristic diffuse gloss that results from cutting corn—in this case, presumably, the wheat and barley that grew wild in the neighbourhood. The handles, which might be as much as 15 in. in length, were surmounted at the nearer end by a carved animal head. We have seen, too, that the early farmers at Sialk in Persia used very similar sickles of flint set in bone, though in some cases the implements were smaller and carried only a single flint. The bone mounts still bore carved heads, generally of an animal, but in one case the figure of a man. Later on, both at Carmel and at Sialk, the use of bone handles was discontinued, wooden handles taking their place both here and elsewhere. The earliest known specimen of a wooden mount —that from the Fayum (fig. 2, 3)—lacks any kind of adornment, but the characteristic row of flint flakes, set in a groove along one side, still persists.

Why should the Natufian reaping-knife have taken this peculiar form? Why should not the edge of a sharp flint have been held in the hand to cut the corn, as appears to have been done by some peoples in much later times? In the first place, Mesolithic (food-gathering) peoples did not, as a rule, strike large flakes of a suitable size to be used for such a purpose as this. On the other hand, they were in the habit of barbing their spears and arrows with rows of tiny flints which must have been set into the sides of the wooden shafts, and it is but a small step from this to setting the flints end to end in a grooved stick, in such a way as to form a continuous cutting edge. The composite blades thus formed may have been used as general purpose knives for cutting meat and other things, and such knives would naturally be used for cutting wild corn in those areas in which it grew. This may be so, but we have no proof of it, such as the discovery of implements of this kind surviving in Mesolithic settlement-sites outside the area in which cereals grew wild. In any case, why were bone

handles used instead of wood by the Natufians and Sialk folk? And why were they adorned with carved heads of animals?

It is possible that there may be more here than meets the eye, for the habits of primitive folk are not governed, as ours are, only by considerations of utility and sentiment, but also by conceptions rooted in magic. It may be that in setting a row of flint teeth in a grooved bone he was imitating the jaw-bone of a grazing animal, and that to make the identification more certain he carved the head of such an animal at the end of the bone. In this way, perhaps, he may have hoped to secure for himself some of the skill and facility shown by a wild ox or ibex as it shore off the wild corn and other grasses with its teeth.

At any rate it must have been difficult work carving those bone handles, and especially the grooves for the flints, using only flint tools, so that it is not surprising that in due course bone gave place to wood for this purpose. We know very little about the early wooden sickle-handles because most of them have perished, but we do know that one of the earliest—the specimen from the Fayum in Egypt—consisted of a straight handle, but without any carved head. By the early dynastic period (i.e., from 3000 B.C. onwards) the wooden mounts of the Egyptian sickles had become L-shaped or curved, with the handle more or less at right angles with the part carrying the flint teeth. In this form they resemble more than ever the one half of the jaw-bone of an animal. This angular form, which is the prototype of the bent form of all subsequent sickles and scythes down to the present day, is also seen in the contemporary clay sickles of Mesopotamia.

The late Sir Flinders Petrie found at Kahun in Egypt two complete specimens of angular flint sickles of wood (twelfth and seventeenth dynasties), each with its row of flint teeth set in some kind of mastic. These flints had been neatly trimmed to fit in with one another so as to present a continuous cutting edge, and together they formed a crescent which fitted into the concavity of the curved wooden mount (fig. 14, 1). Though

Fig. 14.—The Development of the Sickle in N.W. Europe. 1, *Composite crescent of three flints in original wooden handle; Kahun, Egypt, 12th dynasty* (after *Petrie*). 2, *Crescentic flint Sickle of Scandinavian type; mounted as No.* 1. (*Cf. Plate XI,* 1.) 3, *Flint Sickle of British type; one horn of the Scandinavian crescent has become a butt or tang; mounted as Stenild specimen* (*plate XI,* 2). 4, *Flat bronze Sickle, mounted as No,* 3. 5, *Socketed bronze Sickle, British type.* 6, *Iron Sickle with wing-socket; Iron Age; the Caburn, Sussex.* 7, *Balanced iron Sickle; medieval Danish.* 8, *Leaf-knife; Viking period; Norwegian.*

All wooden handles except No. 1 *are hypothetical, but indicate probable methods of hafting.*

the wooden parts have rarely survived, the very characteristic flint teeth are found in large numbers in Egypt and Palestine and other countries bordering the Mediterranean as far north as the Alps. In Palestine flint sickles of this kind were used as late as 1200 B.C., if not later. In north Italy and in Spain specimens of the actual wooden mounts, similar to those used in Egypt, have been discovered dating from about 2000 B.C., but as the use of this implement spread towards the north we can see how the originality of the European peoples began to introduce modifications where the conservatism of the Orient had maintained the traditional form for over a thousand years.

The composite blade, made up of a row of flint teeth set end to end, was, as we have seen a legacy from the

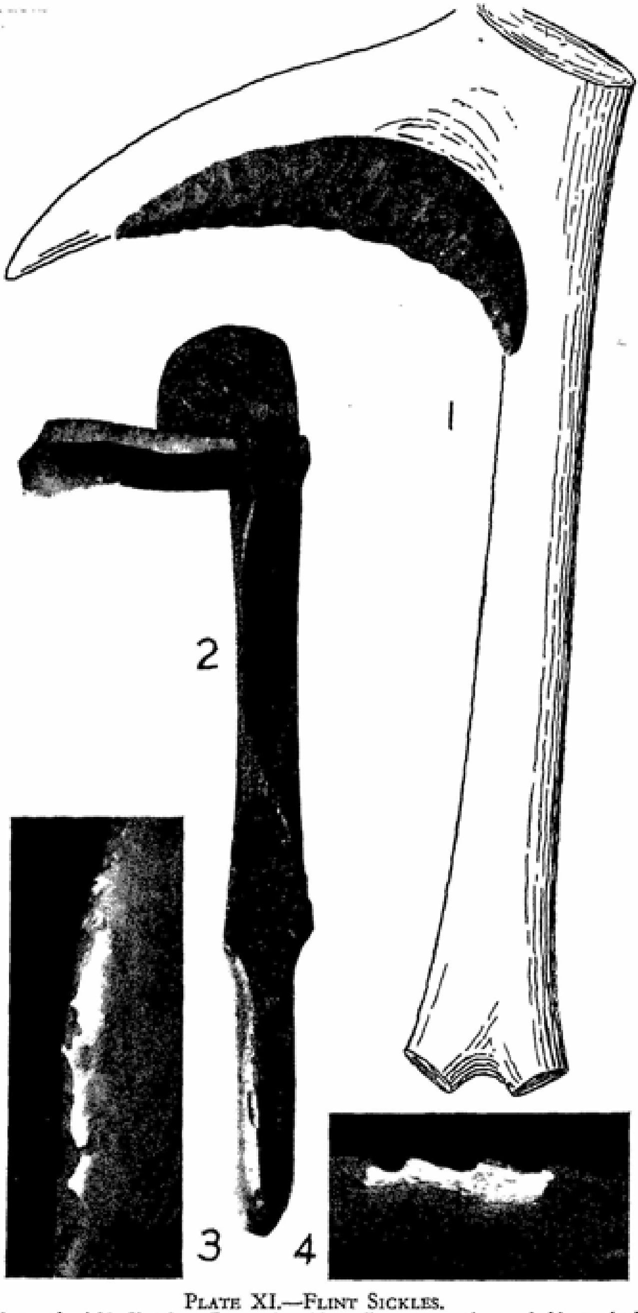


PLATE XI.—FLINT SICKLES.

1, Crescentic sickle-flint from Denmark, with outline representing probable method of hafting in forked branch. 2, Flint sickle-blade in its original wooden handle, found in a bog at Stenild, Denmark. 3 and 4, Corn-gloss on flint sickle-blades, magnified (3, from Britain; 4, from Mesopotamia).

days of the Mesolithic food-gatherers; such a composite blade in its wooden mount was found at Solferino, near Lago di Garda in north Italy. But in the Alpine lake-villages, besides numerous flint teeth that once formed such composite blades, there have occasionally been found crescent-shaped blades of one piece of flint that have evidently taken the place of a group of several flint teeth like those found in the Solferino and Kahun specimens. After all, why make your crescent-shaped cutting edge out of five pieces of flint carefully fitted together, when your skill in flint-knapping enables you to make it out of a single piece?

It was in Denmark and southern Sweden that the single-piece crescentic flint sickles were most fully developed. Large numbers of beautifully worked specimens have been found there, about half of which show corn-gloss along the concave edge. Traces of resin were also found along the convex edges of some Swedish specimens, so that there can be no doubt that these crescentic blades represent, as it were, single-piece versions of the Egyptian sickle, and that they were mounted in the concavity of a similar curved wooden handle (plate XI, 1, and fig. 14, 2). Their range of date in Denmark is between 1800 and 1600 B.C., after which they were for a short time copied in bronze—a crescentic bronze blade taking the place of the flint and being mounted in the same way.

Before the flint crescents had gone out of use, however, a change in the method of mounting began to appear. The traditional curved wooden mount had been necessary in order to hold together the separate elements of the original composite flint blade, such as were used in the countries bordering the Mediterranean. Now that the composite blade was replaced by the single-piece flint crescent there was really no further need for a wooden support along the whole length of the back of the blade. All that was necessary was to secure the nearer end of the blade to the wooden handle and to provide a stop to keep the blade at right angles to the handle. Fortunately a complete wooden handle of this type, together with its flint

blade, was found preserved in peat at Stenild in Jutland, the blade showing traces of corn-gloss (plate XI, 2). In this specimen the flint, which is an unworked flake, is set in a hole cut in the side of the straight handle, so that it projects at right angles, while a prolongation of the handle beyond the flint supports part of the back of the blade and acts as a stop to prevent it from being forced back.

The new method of hafting led in turn to a modification in the shape of the flint blade. The crescentic form was now no longer quite suitable, so one horn of the crescent was straightened out and made to end in a blunt butt, or sometimes a tang, which could be inserted in the hole in the side of the handle (fig. 14, 3). As one would expect, the corn-gloss that is found on many of the blades of this shape is concentrated largely on the horned end and avoids the butt altogether.

This kind of flint sickle-blade is much less common in Denmark than the crescents, but they are also found in Britain where the crescents are virtually absent. They may not have been in vogue for long, because any long, sharp-edged flake would serve the purpose just as well, and in fact, it was just such a flake that was found in the Stenild sickle itself; but another reason is that bronze was just then coming into more general use, and bronze sickle-blades, modelled on this one-horned flint type and undoubtedly mounted in the Stenild manner, soon came to oust their flint prototype altogether. Bronze blades of this kind were flat, and had a little knob at the butt end to fix them to the handle; they remained in general use in Britain till 1000 B.C. and in Denmark till about 600 B.C. (fig. 14, 4.)

There is no need to go into all the complexities of the development of bronze sickles throughout Europe and Hither Asia. It is enough to say that in Britain between 1000 and 500 B.C. bronze sickles developed a socket into which the end of the handle was inserted, the implement so hafted generally maintaining the same shape and appearance as one hafted in the Stenild manner (fig. 14, 5).

When iron came into general use the tendency at first was

for each region to model its iron sickles on the bronze types that had been current locally, subject to the modifications necessitated by the difference in technique of manufacture—for while bronze was cast, iron was always wrought. Thus in Britain the iron sickles had a kind of socket, recalling those of the bronze sickles, but made by hammering wings round the end of the haft (fig. 14, 6), while in Denmark, where socketed bronze sickles were unknown, the iron sickles simply had a tang which was fastened to the underside of the end of the haft.

The supreme importance of iron lay in its cheapness and ease of manufacture as compared with bronze. This not only made it possible to make a large quantity of tools, but individual specimens could be made much larger and therefore more efficient, and new types and varieties could be developed to meet special needs. Thus from the original sickle four different implements were developed—the sickle itself, the scythe, the leaf-knife or bill-hook, and the pruning-hook.

In the kind of sickle we have so far been considering all the weight of the blade lies to the left of the handle while the instrument is in use, as a consequence of which there is a constant tendency for the point to turn downwards towards the ground. This in itself limits the length of the blade that can be used in such a sickle, for a long blade would be quite unwieldy, tiring the wrist in its effort to prevent the handle rotating in the hand. In an effort to check this tendency the handle was so shaped that it would not revolve easily in the hand, and for this purpose the nearer end was generally made to hook round the little finger. While these *angular* iron sickles persisted fairly late in northern Europe, the *balanced* type, to which modern sickles and swap-hooks belong, first appeared in the Alps and in Transylvania during the last two centuries before Christ. The double advantage of the balanced sickle lies in the complete elimination of the tendency for the blade to turn downwards, thus permitting the use of a much longer blade. This is achieved by curving the blade and its tang into the form of a query-mark, so that the axis of the tang and haft

passes through the centre of gravity of the blade (fig. 14, 7). In Britain the balanced sickle was used by the Saxons, if not earlier; in Denmark it did not appear till the Middle Ages, i.e., after the Viking period.

The scythe first appears in Celtic times in the Alps and in Transylvania and Austria. There are two kinds of scythe, the short-handled and the long-handled, and they appear to have been derived from various types of bronze and iron sickles into which there is no need to enter here.

The short-handled scythe appeared in Denmark in the Roman Iron Age, being in part derived from the angular iron sickle, and having a rather short and broad crescentic blade, 12 to 14 ins. long, with a tang set at a somewhat obtuse angle and terminating in an up-turned point for driving into the underside of the handle. The joint was additionally secured by an iron ring, and presumably a wedge of wood, as in the modern Norwegian examples. This method of hafting has survived with very little modification in our large modern scythes. In the Viking period the hafting-angle[1] becomes more obtuse, and the blade becomes longer, straighter and more slender, but with the point curving inwards. The blade is often as much as 18 ins. long and from 1 to 1½ ins. wide (fig. 15, 2). The handles of three short-handled scythes found intact at La Tène in Switzerland are from 30 to 34 ins. in length; being straight they must have been wielded with both hands, for it is only so that the implement could have been held in balance. The short-handled scythe apparently never reached Britain; on the other hand it survived in Denmark till the twelfth century, and is still in common use from Norway to north Russia. The modern Norwegian examples closely resemble those of the Viking period in the size and shape of the blade, as well as in the fact that the blades are made of soft iron, but they possess one great practical advantage in that they are now balanced, not by recurving the blade as in the balanced sickle, but by

[1] That is, the angle between the blade and its tang; an obtuse angle indicates that the implement was not balanced by means of a bent handle.

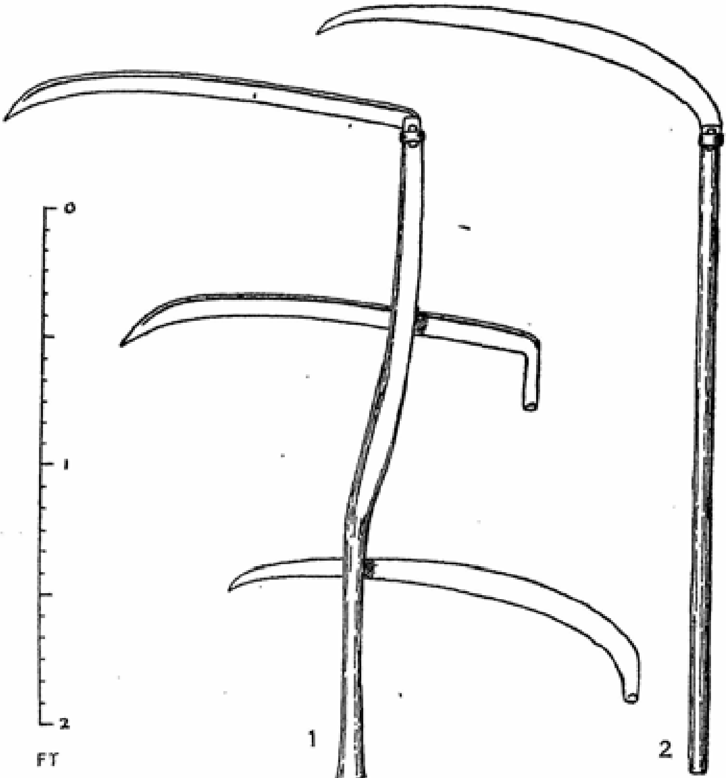


Fig. 15.—Short-handled Scythes. 1, Modern Norwegian, with angular handle for balance. 2, Viking period (Danish), with modern straight handle based on original Swiss specimens.
Note the up-turned point of the tang of each blade, and the method of attachment by collar and wedge. The sneath of the long-handled scythe is about twice the length of the handles shown here.

bending the handle in such a way that the axis of the nearer half of the handle passes through the centre of gravity of the implement as a whole (fig. 15, 1). As a result of this balancing the small scythe can be wielded in one hand, and this is the normal method of using it in Norway where it is used for cutting hay on the mountains and between trees and rocks.

The long-handled scythe has a different origin, and must be traced back to the balanced scythe that is found in Celtic times in Transylvania and Austria. It was developed under the Romans who introduced it to Germany and Britain, where some specimens are of very great size, the blades measuring from 32 to 43 ins. in length. As the blades no longer have a rearward curve like the balanced sickle, and as the hafting angle is acute, we must infer that the balancing of the implement must have been effected by means of a curved sneath, as in the modern scythe. But it was not until the Middle Ages that the long-handled scythe became widely used in Europe.

The leaf-knife was developed for the purpose of stripping leaves from trees for winter-feed for cattle, and it consisted essentially of a sickle-blade set in line with the handle instead of at an angle with it (fig. 14, 8). This implement was the parent of the bill-hook and the hedge-bill. The pruning-hook is a miniature sickle, and, like the bill-hook, was used in Britain before the Roman period.

The significance of the development of the scythe and the leaf-knife during the Iron Age lies in the implication that greater importance was now attached to the winter feeding of cattle. We have already pointed out that this may have been necessitated by the sudden deterioration of the climate of northern Europe at the beginning of the Iron Age, and that in any case the manufacture of relatively large implements of this kind on a fairly large scale was made possible by the change to a cheaper and more easily worked metal.

It may be asked how such small implements as the primitive angular sickles, whether of flint, bronze or iron, could have been used effectively for reaping corn. We have to remember that the ancient method of reaping, as depicted on Egyptian monuments, was to grasp a bunch of ears in the left hand and to sever the straws below them by a shearing stroke of the sickle from left to right. A flint sickle is quite capable of doing this, and not only does experiment show that the stroke from left to right is the only possible one under the circumstances,

but some angular iron sickles have teeth which incline inwards towards the handle, thus confirming the direction of the stroke. This method of reaping was certainly slow and laborious, but no method is really slow to one who has never known a faster, and the adage that 'many hands make light work' was as true in those early days as it is now—in fact, truer in the days when processes were simpler and less technical. The invention of the scythe with its longer handle was due to the need for cutting the grass close to the ground; its application to the reaping of corn came later, as we shall see presently.

Dr. Axel Steensberg of Copenhagen has recently conducted a series of experiments to test the relative efficiency of various kinds of sickles and scythes in reaping corn, such efficiency being gauged by the time taken in reaping a number of plots of barley of equal size, viz., 50 sq. metres each. Using a modern Galician toothed sickle he found he could reap one such plot in 30 minutes; using various kinds of flint and bronze sickles in modern handles he took roughly twice that length of time (in some cases rather more); with unhafted flints he took from two and a half to three times as long as with the modern sickle; and finally, using a replica of a short-handled scythe of Viking type he took about half as long as with the modern sickle. In judging these times a very considerable allowance must be made for the degree to which the reaper is accustomed to his tool. For instance, Dr. Steensberg, working at the rate he did with his modern toothed sickle, would have taken nearly 40 hours to reap one acre of barley; on the other hand, in 1855 it was reckoned that an English agricultural labourer could reap an acre of barley in 5 hours with a toothed sickle. Seeing, however, that in the days when flint and bronze sickles were still used, the area of ground under cultivation was correspondingly much less, these primitive implements were not at so very great a disadvantage. In the primitive settlements in the west of England to which reference has already been made (p. 54) there was about one acre of cultivated land to every ten or twelve huts, probably representing an area of crops

averaging one-third to half an acre per household. Working no faster than Dr. Steensberg did with his flint sickles a family could have reaped their half-acre in 40 man-hours, so that if eight men and women were working on it they could have gathered in their harvest in 5 hours.

Although the scythe was developed for mowing hay it has obvious advantages over the sickle for reaping corn, and it is surprising that these advantages were not made use of earlier than they were. Within the last three centuries, however, the sickle has almost completely disappeared from northern Europe, giving place to the scythe, and the scythe in turn has given place to the harvesting machine. A few details will illustrate this. Whereas in 1672 the sickle was in general use all over Denmark, a century later its use was confined to parts of west Jutland, and by 1833 it was only used in one county. In Norway the sickle was still used in 1872, in Sweden in 1899, and in Finland it is still used at the present day. It appears that although the scythe does the work in one-fifth of the time taken by the sickle, yet where the labour of women and children was plentiful, farmers often preferred to use the sickle. This was especially true in regard to the harvesting of rye, the seeds of which are more easily knocked out by the scythe than by the sickle.

In England the sickle was still preferred to the scythe in 1855, when Henry Stephens gave the following comparative figures: in the course of a 10-hour working day 2·3 acres of wheat per man could be reaped with a scythe as compared with 1·1 acre with a smooth-edged sickle or 1·0 acre with a toothed sickle. For barley and oats the corresponding figures were 4·0, 2·2 and 2·0 respectively. In the Hebrides crops were reaped exclusively with the sickle in 1811 and are still so reaped to some extent at the present day.

The harvesting machine cuts the corn by a method which is entirely different in principle to that of the scythe or the sickle. Unlike the tractor-plough which is developed from the animal-drawn plough, the harvesting-machine is in no way evolved

from the scythe, but is the product of the inventive genius of the machine age—the age of industrial food-production. This illustrates the truth that in a peasant culture implements undergo a gradual and progressive evolution, each stage of improvement being such as could have been effected by the mother-wit of an illiterate peasant, when the desire for greater efficiency triumphs in its perpetual conflict with the natural conservatism of peasant life. On the other hand, in a culture such as our own to-day, based on industrial food-production, conservatism is swept away by the incentive of commercial gain, and improvements, often of the most radical kind, are effected, not by the farm-labourers, but by brains specially trained for the purpose. Such improvements are apt to be revolutionary, and do not necessarily develop naturally out of pre-existing implements and methods.

Before the machine age threshing was usually carried out by one of three methods. In ancient Egypt and south-west Asia a hard, dry floor was specially prepared in the open air, the severed ears of corn were spread upon it and the grain was trodden out by oxen which were driven round and round the floor for the purpose. The grain was winnowed by being thrown up in the air with a shovel so that the wind carried the chaff away and the grain, being heavier, fell into a cloth. If there was no wind a draught was created by means of a fan.

In the Roman world threshing was usually performed with a threshing sledge or tribulum, though this method was much older than the Roman Empire.[1] A sledge with its under-surface studded with rows of sharp flints was loaded with weights and drawn repeatedly over the ears of corn which were spread out over the threshing floor. This method is still practised in Cyprus and elsewhere, and a study of the effects of wear and tear on the flint teeth of the sledge is instructive, for it enables one to recognize their characteristics in the event of such teeth

[1] Biblical references to the threshing sledge include Job xli, 30, where the crocodile is likened to one (see Revised Version rendering); Isaiah xxviii, 27 (R.V.); xli, 15.

being found detached during excavations on ancient sites. Thus the only hint we possess at present as to the method of threshing practised in Roman Britain is the discovery on the site of a Roman villa in Sussex of a single flint bearing the peculiar signs of wear that are found on the flint teeth of a threshing sledge.

Another method consisted in beating out the grain with sticks, and especially with jointed sticks called flails. A flail consisted of two heavy rods of unequal length, joined together end to end by a flexible leather joint. The longer piece formed the handle, and the shorter piece was swung over the head and brought down on the corn in such a way that its whole length fell flat on the floor at once. This was the normal method of threshing practised in north Europe during the Middle Ages, right down to the time of the introduction of the steam threshing-machine, and many flails are to be seen preserved in our local museums.

There is unfortunately no evidence as to the method of threshing practised in prehistoric times in Britain. Numerous shallow hollows are commonly found in the vicinity of farm-sites of the Iron Age (i.e., after 500 B.C.), and it is possible that these may have been places in which the corn was threshed, but of the method actually used we have no evidence. It is quite possible that the ears of corn, rather than the threshed grain, may have been stored after drying or roasting (for which see the next chapter), and that subsequently it may have been threshed in the hand in small quantities as it was wanted for grinding.

In the Old Testament we have a hint that different methods of threshing were suited to different kinds of crop, and that whatever method was used care must be taken not to crush the grain in the process. Thus the prophet Isaiah enumerates four methods suited to different crops: the threshing-sledge, the wheels of a cart, and beating with a 'staff' and a 'rod'—whatever may have been the distinction intended between the last two (Isaiah xxviii, 27, R.V.).

BOOKS AND ARTICLES

Axel Steensberg, *Ancient Harvesting Implements*, Copenhagen, 1943, summarized and reviewed by E. Cecil Curwen in *Antiquity*, XVII (1943), 196.

René Neuville, 'Les Débuts de l'Agriculture et le Faucille préhistorique en Palestine', *Recueil de la Soc. Héb. d'Explor. et d'Arch. Palest.*, Jerusalem, 1934, summarized and reviewed by E. Cecil Curwen in *Antiquity*, IX (1935), 62.

André Vayson de Pradenne, 'Faucille préhistorique de Solférino', *L'Anthropologie*, XXIX (1919), 393, summarized by E. Cecil Curwen in *Antiquity*, IV (1930), 179.

E. Cecil Curwen, 'The Early Development of Agriculture in Britain', *Proc. Prehist. Soc.*, IV (1938), 29–35.

Grahame Clark, 'The Curved Flint Sickles of Britain', *Proc. Prehist. Soc. E. Anglia*, VII (1932), 67.

Sir Cyril Fox, 'The Socketed Bronze Sickles of the British Isles', *Proc. Prehist. Soc.*, V (1939), 335.

O. G. S. Crawford, 'A Primitive Threshing-machine', *Antiquity*, IX (1935), 335. See also *Antiquity*, XI (1937), 93.

CHAPTER VIII

DRYING AND MILLING

WHEN the grain had been harvested, some was set aside for seed-corn for the next season, and some was stored for use as food. Practises naturally differed among different people at different periods, but in general the grain that was to be used for food had to be dried first, and in many cases it was actually roasted. This latter was practised by the Egyptians, and in the Old Testament we find references to 'parched corn'. Probably there may not always have been a clear distinction between drying and roasting, but there were two reasons for doing either, viz., to prevent the grain from germinating during storage, especially in a damp climate, and to facilitate the process of grinding which is very much more difficult with undried grain. In the case of barley and oats, too, the application of heat helps to separate the grain from the tightly enclosing husks. Incidentally, wheat that has been roasted has a very much more appetizing flavour; also when ground the meal is apt to be yellowish in colour.

In Britain during the Iron Age (i.e., from the fifth century B.C. to the first century A.D.) we learn from the classical writer Diodorus Siculus, that the ears of corn were cut off and stored in underground repositories.[1] These grain-storage pits are a familiar feature of Iron Age settlements on the chalk Downs of southern England, and it is quite obvious that if grain was to be stored in such damp places the lining of the pits with straw or basketry would not prevent corn from deteriorating unless it had been thoroughly dried first, with sufficient heat to kill the germ and thus prevent germination. There is reason to believe that at this period the grain was dried or roasted by means of heat derived from red-hot flints, for vast numbers of heat-crackled flints are found on these sites. Possibly the severed ears of corn were spread out on a wattle and suspended over a bed of hot flints, but of the actual method we have no certain knowledge.[2] As we are told by the same writer that the corn was taken from the storage pits in small quantities as it was required for food, we may probably infer that the threshing was done by hand at this stage, for it had been deposited in the pits as ears and not as threshed grain. A century or more ago the Highlanders had a method by which a small quantity of oats could be rapidly roasted and threshed in one process : fire was set to the ears of a bunch of oats held in the hand, and just at the right moment the fire was beaten out, and the hot grain fell readily out of the husks and was ready for grinding.

During the Roman period in Britain a new method of drying corn on a rather larger scale was introduced from the Continent because at this time corn was being grown in much larger quantities for export. The grain, whether still in the ear or already threshed, was spread in a barn on a prepared floor underneath which ran a flue. At one end of the latter was a pit forming a stoke-hole where a fire was kept burning in the mouth of the flue ; the hot air and smoke was carried along the

[1] Diodorus Siculus, V, 21.

[2] The clay-domed ovens postulated by Bersu (*Proc. Prehist. Soc.*, VI (1940), 62) do not sound altogether convincing.

flue and in some cases entered a space below the floor on which the grain was spread, escaping ultimately by a chimney. In other cases, especially in the less elaborate village kilns, the hot air and smoke must have filled the whole of the little barn covering the drying-floor, finding its way out by a hole in the roof. Several of these kilns have been found, some of them on the sites of Roman villas, which were highly organized farms,

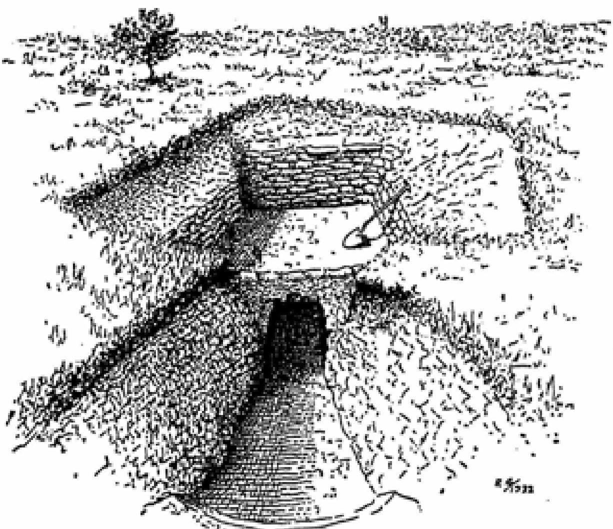


Fig. 16.—Roman Corn-drying Kiln, Thundersbarrow Hill, Sussex.

and others on the sites of peasant villages (fig. 16). Most, if not all, appear to have been in use during the fourth century A.D. A few centuries earlier the poet Ovid had referred to corn-drying kilns as they were known on the Continent in his time, and he mentions that the peasants' chief anxiety in regard to them was the ever-present danger of fire, for it is likely enough that the barn covering the kiln may have had a thatched roof.

Corn-drying kilns have been used in the Hebrides, the

Shetlands and the Orkneys down to the present century. Here the principle has been to spread the unthreshed corn on sticks and straw supported by low walls, with a peat fire smouldering below it; the details of the arrangement vary in different districts. In Ireland the oats were often dried in an iron pot over a fire if a proper kiln was not available, and then they were ground in the husk, the chaff being separated by sifting afterwards.

As has been mentioned above, the grain that was set apart for seed could not be dried or roasted, as that would prevent it germinating. Some other method of preserving it dry and mouse-proof had, therefore, to be found. In the Iron Age in Britain it seems that the usual procedure was to erect a platform on four posts in the farmyard, probably thatched to keep off the rain and the birds, and on this platform to keep the grain in pots or baskets, well out of the reach of mice, rats and other animals (plate XII).

Previous drying of the grain greatly facilitates milling. Grain that has not been dried tends to be crushed rather than ground, and the process has to be greatly prolonged in order to produce the desired result. Using a restored Roman hand-mill (or 'quern') the author ground a pound of roasted wheat to fine flour in a few minutes, putting it all through the mill twice over;[1] under the same conditions a pound of undried wheat took nearly three-quarters of an hour to grind, having to be put through the mill eight or nine times. This is because roasting makes the grains more brittle and less liable to be crushed or flattened. Professor Hatt of Copenhagen found the remains of coarsely ground barley in excavating the site of an Iron Age house in Denmark, and he was able to show by the angular fragmentation of the particles that the grain had been roasted before being ground.

If the Natufians of Palestine gathered the wild wheat and barley that grew round about them they left behind them no

[1] According to P. W. Joyce two Irishwomen could grind 10 lbs. of meal in an hour on a quern (*Social History of Ancient Ireland* (1903), II, 348).

Plate XII.—Reconstruction of a British Farmhouse of the Iron Age (about 300 B.C.)

Based on ground-plan, etc., recovered in excavations at Little Woodbury, near Salisbury. Note circular house with porch, and central smoke-hole, corn-drying racks, thatched stands holding jars of seed-corn, and palisade surrounding the farmyard.

Ph.: Crown Film Unit; Crown copyright reserved.

recognizable implement with which they may have ground the grain. On the other hand, their cultural heirs, the people of Sialk in Persia (see Chapter II), who used flint sickles rather similar to those of the Natufians, ground their grain on *saddle-querns*. This implement consists of two stones—a lower stone which is elongated and has an upper surface which is often slightly concave longitudinally, giving it a fanciful resemblance to a saddle; and a smaller, bolster-shaped upper stone, sometimes called the rider, which lay athwart the lower and was pushed backwards and forward upon it. In Egypt models have been found depicting the method of its use (fig. 17), and this is further illustrated by the practice of some modern African peoples who still use the same implement. A girl kneels on the ground with the lower stone before her, placed so that its grinding surface slopes somewhat away from her; she grasps the upper stone with both hands and alternately pushes and pulls it forwards and backwards the length of the lower stone, bending her body at knees and hips in so doing. Releasing one hand from time to time she feeds the grain on to the nearer end of the lower stone, whence it percolates down the slope between the two stones as it is ground, and falls off the far end in the form of meal.

Fig. 17.—Egyptian Statuette illustrating the use of the Saddle-quern (5th dynasty). (After *Bennett and Elton.*)

For thousands of years the saddle-quern was the only implement for grinding corn that was known to the ancient world.[1] Every reference to a 'mill' in the Old Testament and in Homer must be understood to indicate a saddle-quern, and

[1] Some peoples used a one-handed variety sometimes called a grain-rubber, but the distinction is of little importance except perhaps for tracing the spheres of influence of different cultural groups.

when an artist depicts Samson grinding in the Philistine prison and shows him turning a huge revolving mill by means of a lever, he is perpetrating just as great an anachronism as if he pictured Magna Carta being signed with a fountain pen or Robin Hood armed with a rifle.

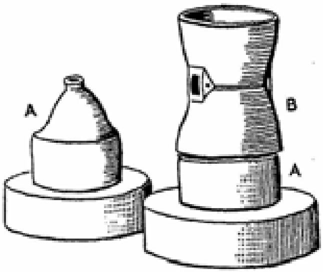
In Classical Greece the saddle-querns were much more carefully made, and the upper stone had a slot cut through it to serve as a hopper into which the grain was fed. A rod was then fastened across the upper stone; one end of this rod was fixed to a pivot on the table on which the implement lay, and the other end was pushed backwards and forwards by the operator, thus exerting considerable leverage on the heavy stone.

The origin of the revolving mill is still wrapped in some obscurity. It first appears in the Mediterranean world in the fifth century B.C., part of a large donkey-mill having been found in Sicily in a level of this date. Revolving hand-mills, or *rotary querns*, appear to be somewhat later in their appearance, according to present information, though the subject has not received the attention it deserves at the hands of Continental archæologists.

The revolving mill is so great an advance on any previous appliance that it cannot possibly have come into being by the normal process of development. The saddle-quern had been essentially an implement of peasant culture, because it sufficed to grind the corn which the peasant grew for the support of his family, but would not have been adequate for the production of flour on a commercial scale unless large numbers of such querns and an equal number of workers were employed. There is therefore no likelihood that a peasant should suddenly have invented a rotary quern to take the place of his saddle-quern. This would have involved too large a step forward in mechanical principles for an illiterate countryman to have thought of. With the possible exception of the potter's wheel the revolving mill is the earliest piece of machinery to replace a to-and-fro movement by a continuous rotary one. This is the principle of most modern machinery, whereby, for instance, we have the circular

saw instead of the to-and-fro movement of the hand-saw, and the ship's propeller instead of oars. Such an advance could only have been the product of a brilliant engineer or mathematician—some forgotten forerunner of Archimedes who failed to achieve the immortality of the classics. It is, moreover, essentially a product of urban civilization and of industrial food-production, hence we should expect the earliest specimens of this new machine to be made large enough to grind corn on an industrial scale.

This is apparently what we actually find, for so far as is known at present the earliest rotary mill was a large donkey or slave mill (fig. 18). This consisted of a lower stone (*meta*) in the form of a cone, the apex of which carried the iron spindle which supported the upper stone (*catillus*). The grinding surface thus sloped steeply down from the apex at an angle which might be as much as 35 or 40 degrees. The upper stone consisted of a hollow cone—or more usually two hollow cones placed apex to apex, like an hour-glass open at both ends; one end fitted over the conical lower stone, while the other served as a hopper into which the grain was thrown. An iron bridge, called in English the rynd, was placed across the narrowest part of the opening between the two hollow cones, and rested



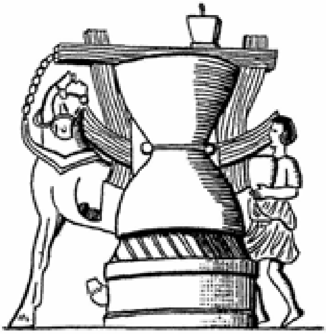


Fig. 18.—*Mills worked by animal or slave labour.* Above: *Mills at Pompeii.* A, A, Meta, *or lower stone.* B, Catillus, *or upper stone.* Below: *Relief depicting a horse-mill and showing the wooden framework by which the upper stone was turned.*

on the top of the spindle. Alternatively a wooden framework embraced the upper stone at its narrowest part, and to this a bar crossing the top of the hopper was firmly attached; this cross-bar, then, rested on the top of the spindle. This latter method may have been the earlier of the two, for it suffered from obvious mechanical disadvantages. The upper stone was turned by two large horizontal levers set in sockets on its sides; to these levers donkeys or other animals were harnessed, or slaves might be chained, and the unfortunate creatures were made to walk round and round in incessant circles. Meanwhile the grain thrown into the hopper percolated down the slope between the two stones and emerged in the form of meal at the circumference.

This apparatus seems to have survived practically unaltered from the fifth century B.C. to any rate the first century A.D., if not later, the best known specimens, belonging to the latter date, being those still preserved at Pompeii. As a machine it was no doubt highly efficient and did the work of many saddle-querns with a fraction of the labour; it was thus admirably suited to milling on a commercial scale. Where it was first invented we cannot yet say, but we suspect that it may have owed its existence to Greek science and engineering. Curiously enough, the Romans seem to have been slow to adopt the device, clinging as they did to the use of the pestle and mortar which was used by the bakers for grinding their own corn as late as the first century A.D.

But besides peasants and townsfolk there were other important people for whom corn had to be ground in bulk, and these included armies on campaign and sailors on a voyage. For them the donkey-mills were quite unsuitable owing to their size and weight, so some other apparatus had to be provided. The saddle-querns were by now out of date, and the Greeks did not use the mortar as the Romans did. The most natural thing would be for the Greek armies to make small, portable versions of the donkey-mill which could be turned by hand by one or at most two operators, and this is apparently what they did,

producing the hand-mill or quern. So far as can be judged from the scanty datable material from the Continent the earliest querns reproduce something of the form of the donkey-mill, being tall and narrow, and most of them had handles which projected sideways like the levers of the larger machine. Querns are well attested in southern Europe by the second century, B.C., if not earlier. In the Roman army a quern was provided for each group consisting of five to ten men, and they were certainly used by the armies besieging Numantia in Spain in 150 B.C.

When the soldiers were discharged and returned to their peasant homes in Gaul and elsewhere they naturally took home with them the idea of the rotary quern, if not a few actual specimens. This soon became an important feature of the La Tène civilization of Gaul and its extensions eastwards to Moldavia, but the idea did not spread to Germany beyond the Roman frontier till the third century A.D. But the La Tène Gauls invaded Britain in the third century B.C.; the first wave of immigrants did not bring with them the rotary quern, presumably because they did not yet know it themselves, but as the La Tène peoples on both sides of the English Channel were in constant communication with each other it is not surprising that the rotary quern appeared on our shores in due course—perhaps about 100 B.C.

The earliest rotary querns in Britain were tall and narrow, with handles projecting sideways, and grinding surfaces that sloped steeply down like those of the donkey-mills (plate XIII, *upper*, and fig. 19, 1, 2). Once introduced to this country the quern underwent gradual development, producing local types, as one would expect to happen in a peasant culture. The old saddle-querns gradually disappeared, though here and there an occasional specimen lingered on into the Roman period, and one has even been found in a Saxon hut. The tendency of the rotary querns, especially in the south of England, was to become wider and less tall, with progressive diminution in the slope of the grinding surfaces, until by the fourth century A.D.

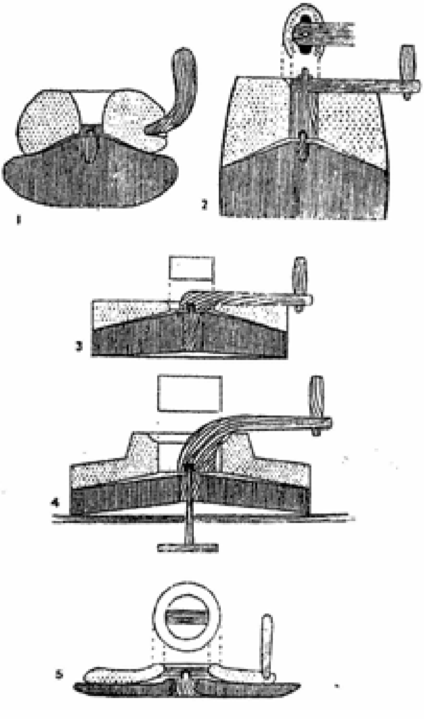


Fig. 19.—Rotary Querns or Hand-mills, with wooden parts restored to show probable methods of mounting. 1 and 2, *Iron Age; Southern England (First or Second Century* B.C.). 3 and 4, *Roman; Sussex (Second and Fourth Centuries* A.D.). 5, *Modern; probably Scottish.*

the stones had become thin and wide and practically flat (plate XIII, *lower*, and fig. 19, 4).

The usual method of mounting them (to which there were exceptions, especially in the Midlands of England) was to put a wooden rynd, or bridge, across the opening in the upper stone, having a small socket on its lower surface, and to let this rest on the point of a wooden spindle which stood in a socket in the centre of the lower stone (fig. 19, 1). The upper stone was in this way suspended above the lower, and adjusted so that the circumference of the two stones were just in contact. The handle was attached in various ways, but in most cases it projected laterally, though it probably terminated in an upright hand-grip.

Other types of quern, made of lava, were imported into Britain during and after the Roman period, and the use of this instrument survived in parts of England until the eighteenth century, and in the Hebrides and Shetlands until the life-time of persons still living to-day (fig. 19, 5).

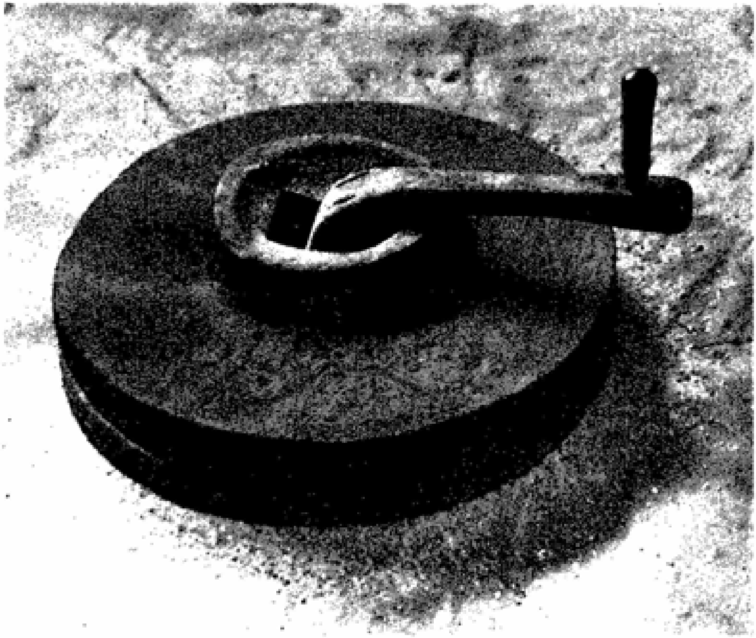


PLATE XIII.—ROTARY QUERNS OR HAND-MILLS, RESTORED.

Above: Before 50 B.C., from Sussex (cf. fig. 19, 2). *Below:* Roman, 4th Cent. A.D., from Sussex (cf. fig. 19, 4). *Phs.:* E.C.C.

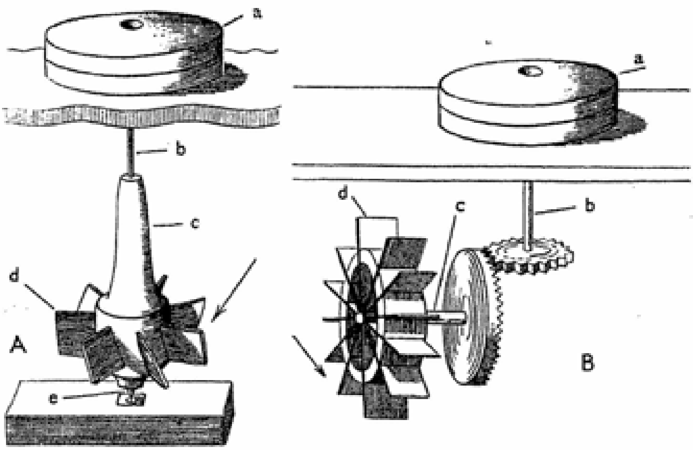


Fig. 20.—The Essential Features of (A) *the Vertical Water-mill, and* (B) *the Vitruvian Water-mill with undershot wheel.* a, *mill stones*; b, *spindle*; c, *shaft*; d, *vanes*; e, *gudgeon.*

During the first century B.C. two kinds of water-mill made their appearance in the Mediterranean world (fig. 20). The simpler and more primitive, called here the vertical mill, is first heard of at the eastern end of that world, possibly at the court of Mithridates, King of Pontus, but more certainly in the neighbourhood of Thessalonika. Whence it originated is an unsolved mystery, but as the type is found to-day right across Asia to China, an Asiatic origin is at least possible. The vertical mill (fig. 20, A) is actually no more than a large quern that is adapted so that it can be turned by water-power; its efficiency is low and its capacity small, so that it remains essentially an instrument of peasant culture, for it is not suitable for milling on a commercial scale. It consists of a vertical shaft or axle carrying a small horizontal wheel at its lower end, its upper end passing through the lower mill-stone and being fixed to the iron rynd which spans the opening of the upper stone. Thus the wheel, shaft and upper stone all move together in one piece and there is no intermediate gearing. The water is directed against the vanes of the mill-wheel by means of a mill-race

and chute (plate XIV). These mills tend to be owned in common by peasants who grind their own corn in them, and several such mills are sometimes worked by a single stream for the benfit of a single peasant-community.

Roman engineers were not slow to adopt this device, while improving its efficiency. One of them, Vitruvius, writing between the years 20 and 11 B.C., describes this improved variety which we shall call the Vitruvian mill (fig. 20, B): a horizontal shaft carrying a vertical water-wheel was geared by cog-wheels to a vertical spindle which turned the upper stone in the same manner as the shaft of the vertical mill already described. This is the principle governing the construction of the medieval and modern water-mills of France, Germany and England, though the mill described by Vitruvius appears to have had an undershot wheel which is only suitable on rivers of constant volume and swift current. This was an improvement on the vertical mill, and it possessed great commercial possibilities. The idea, however, seems to have been pigeonholed for four centuries, for it is not until the latter part of the fourth century that we have any evidence of its use in the Roman Empire. As far as Rome itself was concerned the vested interests of the Millers' Guild were strong enough to resist its introduction so long as paganism survived, for the established mills were worked by animal or slave labour, and the introduction of water-power would have involved the transference of the numerous businesses concerned to fresh sites where running water was available. Upon the general adoption of Christianity, however, the use of animal and slave labour was discontinued, and a substitute for them had to be found. It was then that the Vitruvian water-mill came into its own, and from the end of the fourth century onwards it became the standard mill of the urban civilization of the later Empire. With the invention of the overshot wheel by the fifth century this machine had become admirably suited to the milling of corn on a commercial scale.

When Rome was besieged by the Goths in 536, the besiegers

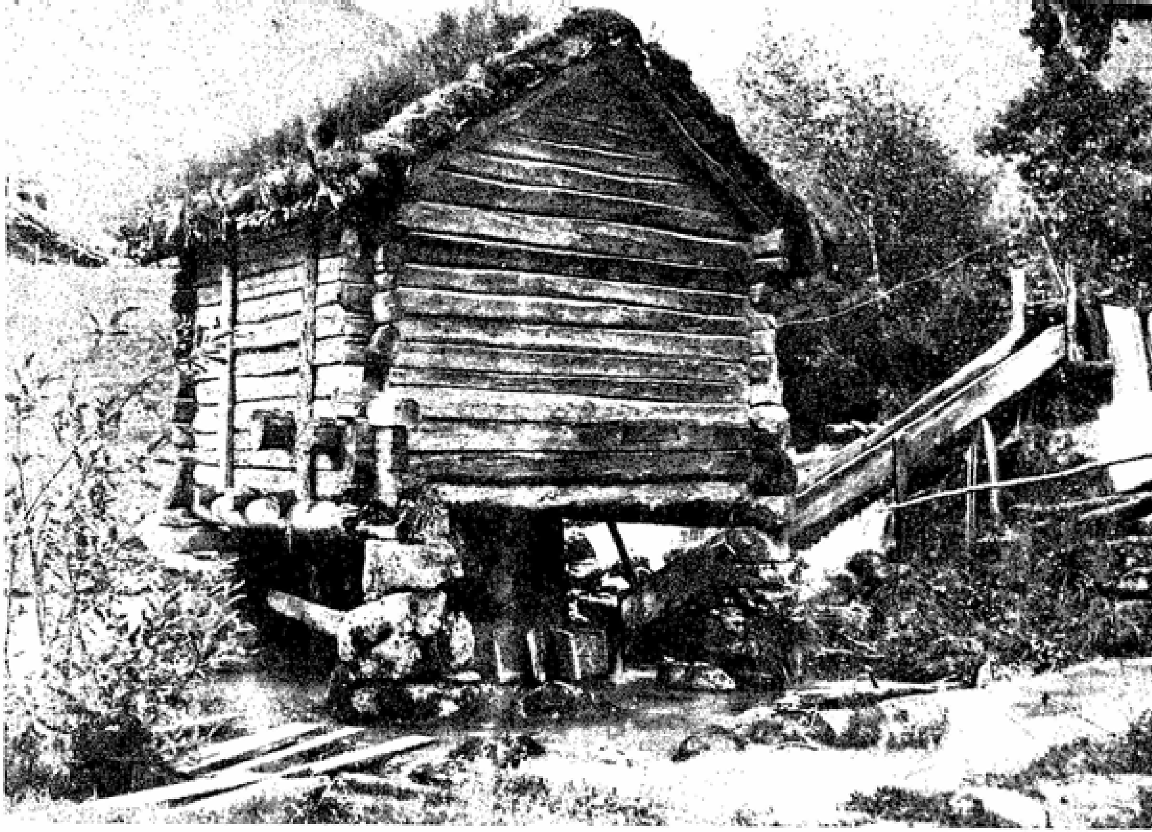


Plate XIV.—Vertical Water-mill, Norway.
Note chute directed on to vanes of horizontal wheel.
Ph. : H. B. Curwen,

thought to starve the citizens by cutting off the water supplying the mills which were then situated on the Janiculum hill. Their design was, however, frustrated by an ingenious device by which some of the mills were transferred to boats which were moored on the Tiber, so that their undershot wheels were turned by the swift current of the river. The Goths and other northern barbarians must have been considerably impressed by these water-mills, and they may well have taken the idea home with them and constructed their own versions of them on the German rivers. At any rate the early distribution of the Vitruvian mill seems to have been mainly northwards through Switzerland and Germany, whence it ultimately reached Britain by the eighth century, if not the seventh. From 762 onwards references to water-mills are numerous in our records, and no fewer than 5,624 of them are listed in Domesday Book (A.D. 1086).

Throughout the Middle Ages the manorial water-mill was an important feature of the feudal system. The lord of the manor had the right to compel every tenant to take his corn to the lord's mill to be ground, and his servants made search for all querns and had them broken up. In this way the water-mill of Vitruvian design, though serving peasant communities, performed a communal function that was analogous to milling on a commercial scale.

Meanwhile the primitive vertical mill continued to supply the needs of the peasant communities along the northern shores of the Mediterranean, where it still survives. It reached Spain, but did not become popular in France because the Vitruvian mill seems to have been known there since the fourth century. There is documentary evidence that the vertical mill was known in Ireland before the Vikings came there, and there is a tradition that it was introduced into Ireland by King Cormac macArt in the third century, which is quite a possible date. There is only one direction from which this mill can have reached Ireland, and that is from Spain, with which country Ireland had frequent intercourse. When the Vikings from

Norway colonized Ireland they found this mill in use, and being impressed with its advantages they introduced it to the rest of their dominions, including the Hebrides, Faroes, Orkneys, Shetlands, and Norway itself (plate XIV). Thus this primitive and ancient contrivance has once existed (and in many cases still exists) in various parts of Asia from China to the Levant, and thence along the northern shores of the Mediterranean to Spain, and so northwards to Ireland and Norway. It provides a striking example of how an instrument of peasant economy can survive even in the presence of a more efficient instrument of urban or industrial economy.

If, then, the quern was developed out of the donkey-mill it may well be that the primitive water-mill was a peasant-adaptation of the quern, and that this was later improved and enlarged by engineers and thus adapted for industrial food-production. What, then, of the windmill? There can be little doubt that this was constructed on the analogy of the Vitruvian water-mill and as an alternative to that machine. It is not known where the windmill was invented, but one may guess that it is likely to have been in some country where the streams were too few, too sluggish or too intermittent for the satisfactory use of water-mills. A flat, wind-swept country might have fulfilled the conditions. The earliest records of windmills show them to have existed in the wind-swept region of Seistan in Persia, certainly in the tenth century, probably as early as the seventh. Modern windmills in Persia have vertical shafts and horizontal sweeps, and are quite unlike those that are familiar to-day in England; it is likely, therefore, that the early examples were of the same kind. During the tenth century the Persians were trading with the Vikings and other natives of north Europe at the mouth of the Volga, while later the Crusades established connections between our Continent and the world of Islam. It is possible that in this way the idea of utilizing the power of the wind as an alternative to water-power may have been introduced to northern Europe. Here it would be eagerly adopted by such people as the Dutch who inhabit

a land which, being flat, affords little scope for water-mills but much for windmills. Being already familiar with Vitruvian water-mills such people would naturally construct their windmills on a similar principle, viz., with vertical sweeps on a horizontal shaft, geared to the vertical spindle which turned the mill-stone. Such a construction is more effective mechanically than the Persian type, and is more easily adjusted to catch the wind from whatever point of the compass it blows. Unfortunately definite historical evidence on these points is lacking.

In spite of beliefs to the contrary there is no reliable evidence of the existence of a windmill in England before 1191 when Dean Herbert erected one at Bury St. Edmunds, only to have it promptly pulled down because it infringed Abbot Samson's milling rights. During the Middle Ages windmills were as common as water-mills and carried the same milling rights as the latter, so that the lord of a manor who possessed a windmill could compel his tenants to bring their corn to be ground at his mill.

The earliest windmills were of the post or so-called tripod type, in which the whole building, which was small, was erected on the top of a post so that it could be turned round to face the wind, from whatever direction it blew (fig. 21). For stability the post was supported by four struts which were fastened to the ends of two sleeper beams which lay cross-wise on or in the ground, the post itself standing on the point of crossing of the two beams. The mill was turned by means of a projecting beam or tail, the free end of which trailed on the ground (with or without the addition of a wheel to carry

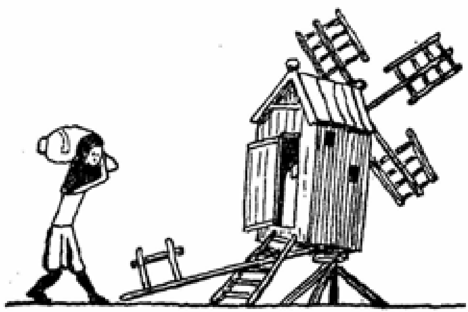


Fig. 21.—Fourteenth-Century Post-mill (after *Bennett & Elton*).

it), describing a circle about the whole edifice. The sites of some of these medieval post-mills can sometimes be recognized, especially on the chalk Downs, by finding a cruciform trench, in which the sleeper beams formerly lay, surrounded at a little distance by a geometrically circular groove made by the tail of the mill as it turned to face the various winds.

Like most other human inventions these post-mills underwent progressive improvements in course of time, resulting in the development of fresh types. The first step was to build a wall round the post and its struts, thus adding a ground-floor chamber to the mill. This was the turret-mill, which as a result of further modifications gradually evolved into the tower-mill. In this, the latest type of windmill, the tower which formed the body of the mill and contained all the machinery did not revolve; only the cap which carried the sail-beam could be turned round to face the wind. Though the tower-mill was developed by the sixteenth century, examples of the earlier types continued to be built and have survived to our own day.

Most of the above methods and contrivances for milling corn have survived in actual use down to the present or very recent times. Saddle-querns are still used in Africa; rotary querns were used in the Hebrides and the Shetlands down to 1914, if not later, and in Algeria and elsewhere down to the present day; the vertical water-mill is used in various parts of Asia, Greece and Norway to-day; and the ordinary water-mill and windmill could occasionally be found working in England as late as the period between the two wars.

But water-mills and windmills, though utilizing the motive-power of the rivers and winds that nature freely provided, were not wholly satisfactory because nature's gifts are fitful and in a dry and windless season both kinds of mill might be brought to a stansdtill for considerable periods. With the increase of business due to the rapid increase of population during the nineteenth century this state of affairs would soon have led to chaos. The increase of population was itself one of the indirect results of the invention of the steam-engine, and so it was

inevitable that this new motive power should be applied to corn-mills in the effort to keep the population steadily supplied with their daily bread. Here again we find in due course one of those abrupt departures from the normal course of development which characterize an industrial as opposed to a peasant economy—innovations such as we have already seen in the invention of the harvesting machine with its scissor-like cutters, and of the revolving mill. In this case the mill-stones were replaced by steel cylinders, the latter bearing no resemblance to the former and not being in any sense derived from them.

One other point deserves notice. All the earlier ideas and improvements in implements and technique came to Britain from overseas—mostly from the Mediterranean basin; from the Middle Ages onwards the initiative passed to north-west Europe and ultimately to England, which became the focus of the Industrial Revolution of the nineteenth century. The initiative in industry will not always remain with Britain; it has already spread to America and is now spreading to central and eastern Europe. Such is progress; nothing is stationary, nothing final. The study of the past therefore helps us to understand the present and plan for the future.

BOOKS AND ARTICLES

Corn-drying:

A. H. Cocks and Prof. W. Gowland, *Archaeologia*, LXXI (1920), 151–8.

E. Cecil Curwen, *Antiq. Journ.*, XIII (1933), 121.

G. Bersu, *Proc. Prehist. Soc.*, VI (1940) 61–2.

R. G. Goodchild, 'T-shaped Corn-drying Ovens in Roman Britain', *Antiq. Journ.*, XXIII (1943), 148.

Aage Roussell, *Norse Building Customs in the Scottish Isles* (London, 1934), 36, 48, 60–2, 66.

Milling:

R. Bennett and J. Elton, *History of Corn-milling*, Liverpool, 1899.

E. Cecil Curwen, 'Querns', *Antiquity*, XI (1937), 133; 'More about Querns', *Antiquity*, XV (1941), 15; 'The Problem of Early Water-mills', *Antiquity*, XVIII (1944), 130.

V. Gordon Childe, 'Rotary Querns on the Continent and in the Mediterranean Basin', *Antiquity*, XVII (1943), 19.

H. P. Vowles, 'An Inquiry into Origins of the Windmill,' *Trans. Newcomen Soc.* (London), XI (1932), 1.

INDEX